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THE SCIENCE OF SPECTRUM ANALYSIS.

Handbuch der Spectroscopie. By H. Kayser. Professor of Physics at the University of Bonn. Vol. i. Pp. xxiv + 782. 251 figures. (Leipzig: Hirzel, 1900.)

THERE are comparatively few men of science who can accurately handle a spectroscope and interpret its indications with assurance. The number of chemists, for instance, who could look at the spectrum of a Geissler tube, and pick out at once the lines of hydrogen, oxygen, nitrogen or carbon, is probably very small. No one denies the importance of the spectroscopic method, but its practice requires so long an apprenticeship and so severe a training, while the experimental facts are so numerous and the pit-falls so plentiful, that the physicists and chemists are inclined to shirk the whole subject and to leave it to the few who happen to have been brought up in a spectroscopic atmosphere.

Part of the cause of this apparent neglect is due to the want of a proper guide to lead the willing but bewildered student through the intricacies of a most diffuse and uninviting literature. We possess only a few short text-books which are quite insufficient for any serious requirements, and various catalogues of papers relating to spectrum analysis which have proved absolutely useless. Prof. H. Kayser, well known as an authority on the subject, has undertaken what must prove to be the work of a lifetime. The first volume of his "Treatise of Spectroscopy" is now completed and will be welcomed by all who desire to know, as well as by those who already know, something of this branch of science.

This volume covers 750 pages and deals, after an historical introduction, with the instrumental methods of producing and examining spectra. There can be only one opinion on the admirable manner in which Prof. Kayser has accomplished his task. He has succeeded in giving a clear and complete account of his subject, and at the same time avoided overburdening his book with details, which the reader can always find in the original papers, to which complete references are given.

The first 120 pages are devoted to the history of the subject, which is dealt with in a fair and impartial spirit. The early papers, in which ideas, *now* so obvious to us, are present in a vague and intangible form, are fully dealt with, but we naturally turn to the exciting time when Kirchhoff and Bunsen finally disposed of all vagueness and created the science of spectrum analysis. Questions of priority never remain long in an acute stage, and no one would now detract one tittle from Kirchhoff and Bunsen's merit because others may have had some correct ideas before them. Balfour Stewart came very near the truth, but it is very doubtful whether, even if his treatment of the relation between absorption and emission had been as rigid and conclusive as that of Kirchhoff, he would have carried the scientific world with him in the way the Heidelberg philosophers did. In fact, only a small fraction of the chemists and physicists who hailed the new discovery with delight could possibly have appreciated Kirchhoff's mathematical deductions. Even making full allowance for the fact that most men are more easily convinced by an argument which is entirely beyond their comprehension than by one which they partially understand, I cannot believe that the turning point in the history of spectrum analysis lay in Kirchhoff's theoretical proof of the cause of the reversal of the bright lines. The most interesting portion of the history of science lies, to my mind, not so much in studying the evolution of clear ideas from vague forebodings of truth (though that, no doubt, is of great importance), as in tracing the particular theoretical argument or experimental fact which carried conviction. In this respect, I should give the foremost place in the history of spectrum analysis to Kirchhoff's experiment, in which he actually obtained the reversal of the sodium and lithium lines, and I should give almost equal value to the clear insight and experimental skill which allowed Kirchhoff and Bunsen to assign the D lines with certainty to sodium alone For the ubiquitousness of these lines was one of the great stumbling blocks which had prevented every real advance, by suggesting that different elements might emit the same vibrations. Even those who had recognised that the yellow lines owed their origin to the presence of a sodium salt had failed to realise that the salt itself was decomposed, and that the lines were due to the metallic element.

There is an interesting incident connected with this point which may be mentioned here, though private conversations, unconfirmed by documentary evidence, have no real value in questions of history. The late Prof. Balfour Stewart assigned his own failure to carry his researches to their logical conclusion to his ignorance of the fact that salt was decomposed in the flame. He made an experiment to see whether rock-salt exercised a selective absorption for light emitted by a sodium flame, and failing to discover such an absorption put the matter aside. But I have been carried away by old recollections, and must pass on from Prof. Kayser's first chapter, which carries the history of the subject to Zeeman's discovery, and the Baltimore experiments on the influence of pressure.

The second chapter deals with the methods of producing luminous vapours. Flames, the voltaic arc, electric sparks in various forms and conditions, and vacuum tubes are discussed in succession; and even those conversant with the subject will find a large amount of valuable information, especially as the author includes in the discussion such questions as the temperatures of different sources, and touches on the theory of the electric discharge.

The third chapter, dealing with prisms, has been written by Dr. H. Konen of Bonn. The passage of rays through prisms is traced, and full justice is done to Lord Rayleigh's investigations, though two propositions in §§ 309 and 310, assigned to Wadsworth, are really contained in Rayleigh's first paper. I think that the investigations of this chapter might have been made clearer and shorter by a more frequent application of Fermat's principle. Special attention may be drawn to the reduction of prismatic measurements to wave-lengths by means of the interpolation formulæ, which have been given by Cornu and Hartmann (§§ 327 and 328). Insufficient attention, to which I must plead guilty myself, has been given

in this country to these equations, which are much more convenient than Cauchy's formula, and which much facilitate the reduction of measurements made with prism spectroscopes. The chapter concludes with a complete description of the various devices for compound and direct vision prisms. The combination of prisms to obtain great dispersion and resolving power has lost a great portion of its interest since the more general introduction of diffraction-gratings for spectroscopic purposes. We therefore turn with special interest to the fourth chapter, which deals with diffraction-gratings.

After a short history of the methods of ruling gratings, a discussion of plane gratings is given, which chiefly follows Rowland's and Cornu's investigations. About thirty pages are devoted to concave gratings. A very clear and elegant theory of these gratings, due to Prof. Runge, is, for the first time, published in full, and deserves to be widely read. It includes the very important practical question of the easiest method of adjusting the relative position of the slit, grating and camera, so that when the carriages roll along the beams, the spectrum should remain in focus and be displaced only in a direction parallel to the plane containing the two rectangular rails.

A disadvantage of concave gratings, which has been pointed out by Rowland in his first discussion, is its astigmatism, a point on the slit being drawn out into a line. It seems to me a curious fact that no one should have attempted to correct this astigmatism by means of cylindrical lenses. I was only waiting until the large concave grating of the Owens College was available, to try some experiments in this direction. Prof. Fitzgerald tells me that he has had the same idea, and has already determined by experiment the proper position of the two focal lines of the correcting lens. In looking over the pages of Prof. Kayser's book, I find that I had overlooked a paper by Mr. J. L. Serks, in the *Journal of Astronomy and Astrophysics*, in which the question is, in fact, solved theoretically. It is curious, however, that the author does not seem to have realised this application of his investigation, which he only applied to proving the possibility of finding a position for a comparison prism such that the horizontal edges of the prism should appear sharp on the spectrum plate. If the light coming from a luminous point is passed through a combination of a cylindrical and convex lens, placed so as to give a horizontal focal line in the position given by Serks, and a vertical focal line coincident with the slit, the astigmatism of the concave grating will be corrected.

The fifth chapter discusses the construction of spectroscopes, a good deal of space being devoted to the various devices for securing minimum deviation. The author seems to me to attach a somewhat exaggerated importance to the minimum deviation as regards its necessity to give definition. If the collimator is properly adjusted, and the faces of the prisms are plane, the spectra should be equally perfect whether the prisms are in the position of minimum deviation or not. When many prisms are used it becomes, of course, necessary that each prism should wholly take in the beam of light which has passed through the previous prism, and, in that case, the position of minimum deviation is most convenient. For the usual prism, cut so that its base is equally inclined to the faces, the position of minimum deviation is also that of maximum resolving power; but the prism may be turned considerably out of the symmetrical position without sensibly affecting its power of resolution.

The theory of the spectroscope, including the question of resolving power and purity, is fully discussed; but I venture to think that the treatment of the brightness of spectroscopic images might be made much simpler and clearer, and in some cases more correct, by starting from the following two very simple principles.

It is a well-known proposition, in the formation of images by lenses, that the brightness of the image, as deduced from the laws of geometrical optics, simply depends on the emitting power of the source and on the solid angle of the converging beam forming the final image. When the observations are taken by the eye, and the whole pupil is filled with light, the last solid angle is fixed; hence the brightness cannot be altered by any optical arrangement. The same proposition also holds when the light is refracted through prisms, provided the light is homogeneous. The second proposition, to which I have alluded, states that if the object is linear, the width of the central image, due to the finiteness of the wave-length of light, also depends only on the solid angle of the conical beam forming the last image.

These two propositions enable us to draw all the necessary conclusions without restrictions, such as that made by Kayser as to the position of minimum deviation of the prisms; and the results of § 508, derived from a paper by Wadsworth, will be found to need correction in some important particulars. The latter portions of this chapter deal with Michelson's researches, the applications of fluorescence, phosphorescence, and finally with photographic and bolometric methods.

The last chapter is devoted to spectroscopic measurements.

The value of the book is increased by the fact that the author has not been satisfied with a statement of results, but in many cases has added his own criticisms. I entirely agree with the statement made in the preface, that a mere compilation without critical discussion is of very little value. In the present volume there has not been so much opportunity of touching on tender spots as will arise in subsequent divisions of the subject; but Prof. Kayser's evident fairness and knowledge of his subject render it certain that no one need be afraid of placing himself under the judgment of so competent an authority. While congratulating Prof. Kayser on the successful accomplishment of the first portion of his task, we conclude with the hope that we may soon be able to welcome a second volume. ARTHUR SCHUSTER.

LIFE AND WORK OF C. GERHARDT.

Charles Gerhardt: sa Vie, son Oeuvre, sa Correspondance: 1816–1856. *Document d'Histoire de la Chimie.* Par M. Édouard Grimaux et M. Charles Gerhardt. (Paris: Masson et Cie.)

A BIOGRAPHY which involves the history of the turning-point of a science is always interesting; and this one in particular, which tells the tale of the

struggles of a young Alsatian, who came to Paris against the desire of his father to fight his way to recognition and fame, is almost dramatic in the way in which it enlists the sympathy of the reader. The story loses nothing by being told by the distinguished son of the subject of the memoir, and by the unfortunate Edouard Grimaux, whose recent death was—at least, in part—due to the jealousy of the Government of France when any attack on its action is made by men in its official pay. Indeed, it may be surmised that M. Grimaux found in the recital of Gerhardt's combats with those in power some consolation for his own recent dismission from office.

Charles Gerhardt was born at Strassburg on August 22, 1816; he passed his schooldays at the Gymnasium there, and his father, in order to prepare young Gerhardt for the charge of a white-lead works which had fallen into his hands as the result of an unfortunate speculation, sent him to Carlsruhe, where, from 1831 to 1834, he studied chemistry and allied subjects. But, on his return to Strassburg, he found the monotonous existence of a works-manager far from his taste; and after stormy interviews with his father, at which he declared his intention to devote himself to the pursuit of pure chemistry, he entered the army as a preliminary step. This step, however, was far from leading him to the desired goal; and, deciding to abandon the calling of a soldier as rapidly as he had formed the intention of taking it up, he applied to relatives in Germany, requesting help to buy a substitute. The help was furnished by no less than Liebig, who had heard of his ability from his teacher Erdmann, and thought it worth while to secure a promising assistant by payment of 40*l.*—the necessary sum.

Needless to say, the money was afterwards refunded by his relatives.

It will be gathered from this short sketch of Gerhardt's youth that he was a young man of very decided character, and that he did not always take the surest way of gaining his desires—that, in fact, he had more of the *fortiter in re* than the *suaviter in modo*.

After having studied for two years at Giessen, then rising rapidly into repute as the first school of chemistry, Gerhardt made his way to Paris armed with a letter of introduction to Dumas and with authorisation to translate Liebig's "Organic Chemistry" into French—a task for which his bilingual education eminently suited him. At first all went well. Liebig's introduction opened to him the doors of the chemists of the day; but he failed, in spite of all efforts, to obtain a junior post. His repeated endeavours to secure a place in a laboratory where he could continue his researches were met with the advice—impossible to follow, under the circumstances—"Do some work, and you will find a place." But in order to continue his researches a laboratory was necessary; and this *impasse* barred his way for months. At last Cahours obtained leave from Chevreul for him to occupy a bench in the laboratory of the *Jardin des Plantes*. Here he carried on investigations on hellenine; and, at the same time, he published a note on the constitution of salts of organic acids and their connection with salts of ammonia.

The reader must peruse the memoir itself if he wishes to become acquainted with Gerhardt's struggles—how his too direct expression of his opinions, in words calculated to irritate rather than to gain converts to his views, hindered his progress. Indeed, his relations—afterwards so intimate and so inseparable—with Laurent, began with an encounter. But both soon found that their ideas of the necessity of a reform in chemistry, and of the manner in which it was to be carried out, were nearly identical; and they joined forces in a campaign against the ruling powers. These powers were not mollified by the manner in which the campaign was conducted. Even Liebig, his old master, might be excused for resenting words such as the following, relating to a nitrogenous substance, a derivative of cyanuric acid, to which Liebig had given the name "mellon":—"Ce n'est pas une partie seulment du memoire de M. Liebig qui est fausse, mais toute l'histoire du mellon, toutes ses transformations, toutes ses reactions." Still, that did not excuse Liebig from saying that Gerhardt reminded him of a highwayman, who attacks and robs travellers and, after having stolen their clothes and ornaments, wears them with effrontery in the streets.

These were, however, days of hard hitting; and had the contest been confined only to words, little harm would have been done. But, unfortunately, the positions of instructors in the provinces and at Paris were so badly paid (and it is scarcely improved yet) that many offices were held by one individual, and places which gave command of several laboratories were occupied by those who were disinclined to abandon any one of them. Thus the best paid of the Government offices—that of Director of the Mint—had a salary attached to it of 600*l.* a year; many of the chairs were worth little over 100*l.*; and the emoluments sometimes became the gift of an elder to a younger member of a family, and were dispensed with little regard to scientific fitness or eminence. Moreover, it is the unfortunate custom in France that if a man wants a position he must ask for it—nay, he must personally supplicate those in power to bestow it on him. Thus, a candidate for admission to the Institute must canvass the members, hat in hand, and report has it that the reception accorded to a candidate is not always flattering to his *amour propre*. But we in England have little reason to criticise; for, though admission to the Royal Society's Fellowship is, fortunately, free from such disagreeable incidents, the candidature for a chair, with its system of testimonials and interviews, might well be reformed.

To return to Gerhardt. After several years of disappointment, he was finally appointed (through Dumas' influence) to the chair of chemistry at Montpellier, at one time renowned for its medical school; here he had only 6*l.* a year to spend on apparatus, and 12*l.* to provide specimens! Moreover, he found his colleagues occupying sinecures, and anxious to retain their chairs, as such, by discouraging the attendance of students. It is exceedingly galling to a "new broom" not to be allowed to make a clean sweep; and it is difficult to keep on terms of sufferance—not to speak of friendship—with what may be disrespectfully called the old besoms. So Gerhardt's new chair was by no means a comfortable seat; and after some years he applied for, and obtained, leave of absence on half-pay—another arrangement which sounds strange in our ears. In the meantime, however, he had married Miss Jane Sanders, a Scottish lady, resident with her mother and sister at Montpellier; this union was,

from every point of view, a happy one. During his leave of absence, Gerhardt came to Paris; and again, it is strange to us on the other side of the Channel, many of whom are content with an occasional visit to the capital, to see how absence from Paris is, to a Frenchman, absence from civilisation. "La vie du province"—there is no expression which so fitly renders the *ennui* of banishment from "ce cher Paris." But to live at Paris was not necessarily to find an official position; and, after many disappointed hopes, Gerhardt finally accepted two chairs at Strassburg! "Le cumul," as pluralism is termed, has attractions, it appears, to those to whom it is offered.

Gerhardt was not long at Strassburg, however, before he succumbed to an attack of peritonitis; and, after a few days' illness, during which he regretted nothing more than the cessation of work, he passed away.

Gerhardt shared with other reformers absolute belief in his own theories, and want of patience with conservatives who would not be convinced. Patience and a more gracious manner would have not only given him a happier and more prosperous career, but would also have accelerated the acceptance of his doctrines. Still, it is difficult for us to judge. Suffice it to say that the formulæ which we still use are, for the most part, Gerhardt's. While Gerhardt referred the formulæ of compounds to the volume occupied by the molecular weight in grams contained in 22·4 litres of the gas, Laurent extended the same numerical conception to the "formulæ" of elements; while Gerhardt wrote H_2O for the formula of water, but O for that of oxygen, Laurent introduced Avogadro's and Ampère's view that the molecular formula of oxygen should be O_2. They united their forces in advocating the adoption of "types," such as that of H_2, H_2O, and NH_3; and Williamson supplemented their ideas by the addition of "double types"—substances derived, for example, from two molecules of water by replacement of an atom of hydrogen in each. Later, as every one knows, this conception developed into structural formulæ. But the idea of a homologous series, too, was first introduced by Gerhardt; and it has proved one of the most fertile in the whole domain of organic chemistry.

We have witnessed as great, if not a greater change in chemical theory during recent years. Fortunately, it has not aroused the same passion, although it has been resolutely opposed by a conservative faction. At the meeting of the French Association at Havre, the writer remembers well a discussion of which the central point was whether the formula of barium sulphate should be written $BaO.SO_3$ or $BaSO_4$. Is it possible that, twenty years hence, we shall still find a remnant for whom the ionic theory has no value? W. R.

MONISM FOR THE MULTITUDE.

The Riddle of the Universe at the Close of the Nineteenth Century. By Ernst Haeckel, Ph.D., M.D., LL.D., Sc.D., and Professor at the University of Jena. Translated by Joseph McCabe. Issued by the Rationalist Press Association, Ltd. Pp. xvi + 398. (London: Watts and Co., 1900.)

THERE is a twofold pathos in this book, for with it the author—whom to know is to love—draws, he says, "a line under his life-work," and with it he once more illustrates the sad fact that a great investigator may not be convincing as a philosopher. The book begins with a reproach that philosophy is ignorant and that science lacks consistency, and we end it with a sigh for the same reasons. As a few readers may remember, Haeckel projected, almost a generation ago, the scheme of a "System of Monistic Philosophy"; but the shadow of age has fallen upon him while his early ambition was still not within sight of being realised. Therefore he has given us in this, "which has something of the character of a sketch-book," only a hint of what might have been. For the non-fulfilment of his dream of youth, the order of things is more responsible than the author, for there are few who have worked harder and, at the same time, more brilliantly for their day and generation.

But although Haeckel speaks of the volume as a sort of sketch-book, this is not meant to suggest that its conclusions are mere *obiter dicta*. On the contrary, as he tells us, he has been meditating for fully half a century on the problems of evolution, and now, in his sixty-sixth year, he gives us "the ripe fruit of his tree of knowledge." If this is not an altogether happy metaphor, it may serve to remind the unsympathetic that we have here, at least, the sincere voice of "a child of the nineteenth century," who is conscious of no dogmatism, though the suggestion of it seems painfully frequent, who blinks no facts so far as he is aware, who is impelled by no motive but a love of truth.

"My 'Monistic Philosophy' is sincere from beginning to end—it is the complete expression of the conviction that has come to me, after many years of ardent research into Nature and unceasing reflection, as to the true basis of its phenomena."

Impulsive the author certainly is, as he has always been—impulsive, for instance, to champion Darwinism in the early days of its unpopularity, and impulsive in his confidence in genealogical trees which many a Jack has hewn at while the giant climbed—but ignorant no one will venture to call the zoologist who has laid so many solid blocks in the scientific edifice, and to whom the Royal Society has lately awarded its Darwin medal. There is, perhaps, no important idea in this volume, admirably translated by Mr. Joseph McCabe, which is not to be found in that wonderful work of 1866, the "Generelle Morphologie"; but the ideas are now illumined with a wealth and confidence of illustration which only a big personal share in the scientific progress of the last forty years could give.

The book, as we have said, begins with a reproach. Scientific workers "do not see the wood for the trees"; the metaphysicians "trouble not about the individual trees, and are satisfied with the mere picture of the wood"; betwixt the two is the multitude, still oppressed by "the riddle of the painful earth." But this incoherence, this ignorance, this oppression result from that blindness to the open secret of unity which is the lasting defect of Western thought. There is but one fact, and, as a writer in the *Monist* recently remarked, it is an evidence of human frailty that the word ever got a plural; there is but one science, the science of the order of nature; there is but one comprehensive riddle, the problem of substance; and there is but one hopeful attempt at solution, namely, of course, scientific monism.

We cannot here discuss the detailed arguments of the book, but the author's standing requires that we should at least indicate the general trend. The chapters run :—the nature of the problem, our bodily frame, our life, our embryonic development, the history of our species, the nature of the soul, psychic gradations, the embryology of the soul, the phylogeny of the soul, consciousness, the immortality of the soul, the law of substance, the evolution of the world, the unity of nature, God and the world, knowledge and belief, science and Christianity, our monistic religion, our monistic ethics, solution of the world-problems. It is from the last chapter that we select a quotation which sums up the author's position.

"Towering above all the achievements and discoveries of the century, we have the great, comprehensive 'law of substance,' the fundamental law of the constancy of matter and force. The fact that substance is everywhere subject to eternal movement and transformation gives it the character also of the universal law of evolution. As this supreme law has been firmly established, and all others are subordinate to it, we arrive at a conviction of the universal unity of nature and the eternal validity of its laws. From the gloomy *problem* of substance we have evolved the clear *law* of substance. The monism of the cosmos which we establish thereon proclaims the absolute dominion of 'the great eternal iron laws' throughout the universe. It thus shatters, at the same time, the three central dogmas of the dualistic philosophy—the personality of God, the immortality of the soul, and the freedom of the will" (pp. 388–389).

There seems some need here for a criticism of categories, but we make only two remarks.

Since, as Haeckel says, "no scientist ever asks seriously of the 'purpose' of any single phenomenon," since, in other words, science does not discuss the meaning or significance of experience, it is obviously *as a philosopher* that he seeks to demolish the ancient beliefs, and there will no doubt be found those who, while bowing to his scientific authority, will prefer Kant or some other as their philosophical guide.

Secondly, to scientific minds who regard laws of nature as merely conceptual formulæ summing-up certain sequences of experience, it may seem that to replace "a deliberate architect and ruler of the world" by "the eternal iron laws of nature" is to be guilty of an anthropomorphism precisely analogous to those on which the illustrious author pours contempt. Altogether, this endeavour to give monism to the multitude seems to us to bear an unfortunate resemblance to the device of trying to pay debts by means of an overdraft without first facing the question of general solvency.

When we say that we do not find in this volume any solution of any of the riddles of the universe, we mean no particular reproach against the author, for he is a scientific worker, and we do not think that it is within the scope of science to solve "Welträthsel." In other words, we adhere to the position that "all science is description, not explanation." If the phenomena which we label gravitational or evolutionary were once riddles, they remain so, although Newton and Darwin have given us what Karl Pearson calls thought-economising devices for dealing with them.

The book falls short of its high ambition because it is neither scientific enough nor philosophical enough to win conviction. It is not scientific enough, since mere formulæ (endowed with "eternal validity") stalk through the book, doing this and doing that, like the Greek gods come back again, and since when the well-known difficulties raised by the "big lifts" in the great process of Becoming have to be faced, the author has no new light to offer (we are not forgetful of his illumining work in the past), but simply rubs his lamp and summons the two genii, Substance and Evolution, and the work is done. In plain fact, Evolution travels through the book like a creator in disguise. There is many a quaint illustration of the metaphysician unconscious of himself, as when the author, after referring the doctrine of the conservation of matter and energy (his "law of substance" or "fundamental cosmic law") to Lavoisier, Helmholtz and others, says: "In the ultimate analysis it is found to be a necessary consequence of the principle of causality."

Nor does the book seem to us philosophical enough; it does not even show an appreciation of the philosopher's problems. In confessing that we are as far from understanding "the innermost character of nature," "the problem of substance" as Anaximander and Empedocles were 2400 years ago, Haeckel says :—

"We do not know the 'thing-in-itself' that lies behind these knowable phenomena. But why trouble about this enigmatic 'thing-in-itself' when we have no means of investigating it, when we do not even clearly know whether it exists or not."

Now many who agree with this assumption of the futility of the "things-in-itself" may at the same time doubt whether the philosopher troubles himself much about it either, whether this is not mere bluffing in presence of the fact that our "routine of perceptions" *is* a problem (not to be ignored, even if insoluble), whether transcendental formulæ have no utility because scientific formulæ (*e.g.* atomic theories, ether theories, &c.) seem to many minds to have much, and whether the position indicated is consistent with the energy expended throughout the book in "shattering" Christian and other philosophies of life which have obviously no standing if from the outset the problem of the significance and meaning of experience is ruled out of court as an irrelevancy. One feels that the author has not quite learned the "rules of the game" when he is satisfied with saying in answer to idealistic monism :—

"In my opinion the existence of ether is as certain as that of ponderable matter—as certain as my own existence, as I reflect and write on it. As we assure ourselves of the existence of ponderable matter by its mass and weight, by chemical and mechanical experiments, so we prove that of ether by the experiences and experiments of optics and electricity."

But this is just Dr. Johnson and Bishop Berkeley over again, and no idealist will so much as turn a hair.

SCHMEIL'S TEXT-BOOK OF ZOOLOGY.

A Text-book of Zoology; treated from a Biological Standpoint. By Dr. O. Schmeil. Translated by R. Rosenstock, and edited by J. T. Cunningham. Parts ii. and iii. Reptiles to Invertebrates. (London: A. and C. Black, 1900.)

THE first part of this school text-book was noticed in our issue of August 23, 1900, and with the publication of Part iii. the work is completed. Considering

the fulness with which it is illustrated, and the somewhat restricted circulation of treatises devoted to zoological subjects, the work is a marvel of cheapness; and the manner in which it is turned out reflects the greatest credit on the publishers. Allusion has been previously made to the popular and interesting style in which it is written; and as examples of clear and accurate treatment of somewhat difficult subjects we may call attention to the description, in Part ii., of a bird's respiration while on the wing, and the manner in which the flight-feathers present either an impervious barrier or an easily traversed sieve to the air according to the exigencies of flight at the moment. The descriptions of these functions are, indeed, decidedly better than in any other text-book with which we are acquainted; and they are by no means solitary instances, both in the vertebrate and invertebrate parts. Again, the diagram of the circulation of the carp on p. 274 may be cited as an excellent example of clearness. And it may be confidently affirmed that, so far as physiology and habits are concerned, the work is for the most part all that can be desired.

But physiology and the description of the habits of animals, although of the highest importance, by no means constitute the whole of zoology; and whether the subject be treated from a "biological" or from any other standpoint, there can at the present day be no sort of excuse for the numerous omissions and inaccuracies which occur in the systematic portion of Part ii. Even if the author's acquaintance with systematic zoology were insufficient to enable him to recognise these shortcomings, it should have been, as we said before, a part of the editor's task to see that these were remedied in the English translation.

Were we so disposed, we could seize many opportunities of finding fault with the generic and specific nomenclature employed; but we will let such minor matters pass without notice, and content ourselves with calling attention to other points.

Taking first the section on birds, we find that not only is the classification of a decidedly antiquated type, and very different from any of those commonly employed, but that it also contains several errors and inconsistencies. The group "Impennes," for example, was formed in 1811 by Illiger for the penguins, but in the present work (p. 225) we find it typified by the divers, which, together with the grebes, constitute Illiger's "Pygopodes"! Nor is this all, for whereas the "Impennes" are termed "Divers," yet no representative of the divers proper (Colymbidæ) is referred to in the work; the notice of the group commencing with the grebes, which are followed by the auks, and these, again, by the penguins—the typical and sole representatives of the entire order. Take, again, the case of the gulls or "Lariform" birds (page 223). Here we have first an account of the herring-gull, followed, under the head of "allied species," with a brief mention of the black-headed gull and the albatross. Of course, it is justifiable to follow Dumeril in including both the gulls and the albatross in a single group (Longipennes), but the reader should have been informed that, according to the universal usage of British ornithologists, the albatross and the other petrels are separated from the gulls as a distinct order (Tubinares).

To take a third instance, those responsible for the book may, if they please, follow the totally obsolete system of including the so-called American vultures (Cathartidæ) among the Vulturidæ, or true vultures of the Old World. But there is no justification whatever for taking the condor as the sole example of the latter family, and avoiding all mention of a single species that really belongs to it! And here it may be remarked that we think ornithologists would be well advised if they discarded the use of the name "Vultures" for the Cathartidæ, and called them all "Condors." Misprints, we are glad to notice, seem few and far between in this and the other sections of the book, but Alaudictæ, in place of Alaudidæ (p. 181), should have caught the proof-reader's eye.

Passing on to the section on reptiles, we have to deplore the use of an antiquated and discredited classification, the groups Ophidia and Lacertilia being regarded as of equal value with Crocodilia and Chelonia. But even more serious is the total absence of the Rhynchocephalia among the ordinal groups of the Reptilia, its single representative, the New Zealand tuatera, being, so far as we can see, not even mentioned in the book! Surely, even from a "biological standpoint," such a remarkable creature is worthy of some notice in a "zoological text-book!"

Nor are minor points for criticism lacking in this section. For instance, on p. 246, the account of the American alligator is simply ludicrous; while the reader should have been informed that an allied species occurs in China. Again, had the editor taken the trouble to refer to the British Museum "Catalogue of Chelonians," he would have found that there is no justification for the use of the name "Chersidæ" for the land tortoises (p. 250), and also that in place of *Testudo indica* being the proper title for the "giant tortoises" of the Galapagos Islands, that name denotes an extinct species from the Mauritius.[1]

Omitting mention of the Amphibians (not because there is no room for criticism), a few remarks are called for in the section devoted to fishes. Here the up-to-date zoologist can scarcely fail to be surprised to find the group divided into (1) bony fishes, (2) enamel-scaled fishes, (3) sharks and rays, (4) round-mouthed fishes, and (5) lancelets, without the slightest indication as to differences in the value of such divisions. To those who have kept themselves at all abreast of modern zoological research, it is almost inconceivable that such a classification should be presented to students.

As regards the details of the class in question, it is decidedly strange to find the "enamel-scaled" group exemplified by the sturgeons, while the two living types (bony pike and bichir) which alone retain scales of this description are totally ignored; and surely the unique type of limb-structure presented by the latter alone among modern fishes should have itself entitled the creature to special mention. Even more startling is the omission of any reference to the lung-fishes (Dipnoi), which we presume the author would include in the "enamel-scaled" group, although the student is left entirely in the dark on this important point.

Without in any way wishing to be unduly severe, we

[1] Neither the popular nor scientific name of this reptile occurs in the index.

can scarcely refrain from saying that in the second part of the work the author seems to have gone out of his way to ignore some of the most peculiar, and therefore the most instructive, types of reptile and fish life.

As regards Part iii., which deals with invertebrates, we feel ourselves less qualified to speak authoritatively either in respect to the excellence of treatment or the reverse on the part of the author, and therefore refrain from detailed criticism. So far, however, as we can judge, the classification adopted is, in some respects, less open to objection than is that of the vertebrates. Even here, however, the author gives opportunity for criticism in many places. For example, among the molluscs no mention is made of Dentalium, which most modern zoologists regard as the representative of an order by itself. And it is scarcely consonant with the facts to say (p. 445) that Ammonites "were animals similar to the nautilus in all essentials of form and structure," unless, indeed, the author attaches a very different meaning to the word "essential" than we are disposed to assign to it. But the most astounding feature in the whole book is the total omission of the Brachiopods, the Tunicates, and the Polyzoans!

At the end of the work two pages are devoted to geographical distribution. Here it will surprise many zoologists to find the domesticated zebu given as one of the characteristic animals of the Indian region, and "the antelope" as one of those of Africa. Neither is it apparent why the leopard *and the panther* are included among the characteristic mammals of Africa as distinct from India. Again, the statement (p. 485) that "tracts of land (*e.g.* the Sahara) have been elevated out of the ocean" may be cited as an extremely unfortunate one, having regard to modern views as to the origin of deserts.

If the editor in his preface is justified in his statement that "the book is far superior in many respects to any other elementary text-book of the subject known to me," we may be permitted to add that in other respects it is decidedly inferior to several works of the like nature that could be named. R. L.

OUR BOOK SHELF.

The Mycetozoa and some Questions which they Suggest. By the Right Hon. Sir Edward Fry, D.C.L., LL.D., F.R.S., F.L.S., and Agnes Fry. Pp. viii + 82. (London: *Knowledge* Office, 1899.)

"WHAT's in a name?" Much, when it bars the way to the knowledge of a group so rich in curious and beautiful forms, and so important in the information that it can afford upon the nature of protoplasm. The want of a familiar name has led the authors to employ "myxies," and the word may find acceptance, as it is not hard to pronounce or remember, while it has the advantage of leaving open the question of what their pets are. Though generally reckoned now among plants, they are so different from even the nearest groups that they may well receive a neutral name.

They have formed the subject of very excellent monographs in various languages, and to these the student must turn who wishes to investigate the Mycetozoa thoroughly. But the very excellence of these monographs renders them unsuitable to those that wish only such a general outline as will place the group in true perspective in its relation to other low forms of living beings, and will indicate its value in the study of living protoplasm in simple organisms. There was room for a small book that would give such an outline, and this little work has been written to do so. One cannot read it without recognising that it is the work of enthusiasts whose aim is to communicate to others the pleasure gained by themselves in the study. But no less evident is the clearness of statement of the points of chief interest resulting from width of view and facility of expression. One can recognise that it is the work of amateurs by occasional slips, as on p. 35, where it is stated that all plants with a square stem and lipped flowers belong to the family of the Labiatæ. But such slips are few, and no one can read the book without interest, while those not already familiar with the Mycetozoa will have gained as clear a conception of their nature and scientific interest as can be acquired without actual personal study of these organisms. The descriptions are supplemented by figures admirably selected and executed. The book is one that should induce those who read it to desire a fuller knowledge and to become students themselves. It will be found an excellent introduction to the study of a most interesting group.

A School Chemistry. By Dr. John Waddell. Pp. xiii + 278. (New York: The Macmillan Co., 1900.)

MANY text-books of physics and chemistry are now constructed upon the interrogatory plan. Judiciously used, the method has real educational advantages, for it makes the student think for himself instead of merely using his brain as an absorbing medium for what he reads or is told. But the Socratic principle is often overdone. The questions which a teacher asks—either in book or verbally—in connection with experiments in progress, are frequently not those which present themselves to the mind of the student. True, by suggesting questions the pupil can be led to see the main points to be brought out, and to have an interest in finding answers to them; but the ideal plan is to let his own mind do the questioning instead of the mind of the teacher. While, therefore, we agree that the interrogative method largely employed by Dr. Waddell is often stimulating, and certainly much better than the plan of former text-books for schools, we do not believe it is altogether satisfactory.

Consider a boy in a laboratory, with Dr. Waddell's book open at Experiments 9 and 10 (Chap. ii.). The experiments are on the decomposition of water by potassium and sodium, and will often result in accidents unless performed under the eye of the teacher. But leaving this out of account, let us see the questions asked in the course of the description of Experiment 10; they are as follows: "Does the potassium sink in the water, or does it float? What colour has the flame? . . . What shape does the sodium assume? Note how far it acts like potassium, and how far it differs. Is there a flame? Try the experiment with *hot* water. . . . Why is there a flame in some cases with the sodium and not with others? What is the colour of the flame? Does sodium or potassium act the more violently on water?" Now a question we would ask is: How is the pupil to give his answers? Is he supposed to write a reply to each interrogation, or merely to make a mental note of it? If the former, then the pupil must soon get weary of the obstacles offered to the progress of his practical work, by the everlasting questions prompted, not by his own curiosity, but by a book. In fact, we do not believe it is possible to carry out the Socratic method of science instruction successfully by means of a text-book. The spirit of inquiry must come from within, or be inspired by a teacher watching the progress of an experiment.

It must not, however, be concluded from the foregoing that Dr. Waddell's book is destitute of the elements of

success. He does not use the plan of questioning to the excess characteristic of some other authors of recent text-books of chemistry; and his book has some special features which make it worth adoption in elementary classes in schools and colleges. The intelligent order in which the subjects are dealt with, and the attention given to industrial processes, are particularly worthy of credit.

Die Photographie im Dienste der Himmelskunde. Von Dr. Karl Kostersitz. Pp. 53. (Wien: Carl Gerold's Sohn, 1900.)

THIS short monograph is a reprint of a lecture given by Dr. Kostersitz before the Vienna Photographic Society. The author describes in a somewhat general way the results that have been obtained by applying the camera to the end of a telescope and turning it towards the heavens. We are thus introduced to the appearance of the general features of the sun in and out of an eclipse, and a brief reference to the planets and asteroids as shown us by photography. Meteor photography is more fully described, and the author here gives two illustrations showing trails as photographed by him. The method of determining the relative brightness of stars by photographing them slightly out of focus is described, and a few words are written about the photography of the Milky Way. The illustrations, which are numerous and good, are chiefly from Scheiner's "Photographie der Gestirne," there being two excellent heliogravures showing the nebula of Orion and Barnard's Milky Way.

The last portion of the book is devoted to the publication of twelve replies that were received from different authorities in answer to a suggestion, proposed by the author, of erecting an observatory on the top of the "Schneeberg." These form interesting reading, although they hardly have any connection with the subject-matter of the book itself.

Although the monograph does not pretend to be complete, yet it gives the reader an idea of the important part played by photography in astronomy.

Die Säkular-Verlegung der Magnetischen Axe der Erde. Von W. van Bemmelen. (Observations made at the Royal Magnetical and Meteorological Observatory at Batavia.) Vol. xxii. Appendix i. Pp. 30.

THIS is an attempt to trace the position of the earth's magnetic axis during the last three centuries, on the supposition that a knowledge of magnetic declination is sufficient to determine the direction of its axis. Great circles drawn through different points, and coincident at these points with the magnetic meridians, would intersect in the poles of the magnetic axis, if the earth were a uniformly magnetised sphere. As this is not the case, the circles all pass through an arctic and an antarctic region instead of through two points, and Mr. van Bemmelen calculates by the method of least squares the point in each region which is nearest to the circles. The two points thus found he takes for the intersections of the magnetic axis with the earth's surface. The reader must be referred to the original for the clever manner in which the calculations are simplified and carried out. The method is first tested for the year 1885, when it is found that the magnetic axis, calculated in this fashion, agrees closely with that derived from the more rigorous analysis of Neumayer and Ad. Schmidt. It is then applied to the declination values for the years 1600, 1650, 1750, 1770 and 1842, and the author draws from the results thus obtained the conclusion that the magnetic axis does not revolve round the geographical axis, but that there seems to be a tendency to revolve round Nordenskjöld's aurora pole. A doubt must necessarily arise in the mind of the reader as to how far the older observations are sufficiently numerous and correct to allow any certain conclusions to be drawn from them. Any one looking at Neumayer's Atlas (Berghaus) of Terrestrial Magnetism will be struck at once by the fact that the distribution of magnetic declination in the year 1600 is represented as being widely different from that of a uniformly magnetised sphere. We must conclude that either the observations were not sufficiently accurate to give us a correct picture, or that the earth differed much more from a uniformly magnetised sphere at that time than it does now. As v. Bemmelen has only tested his method at a time when the deviations from uniformity were small, there is considerable doubt whether equally good results would be obtained with irregular magnetisation. The work, meritorious and interesting as it is, cannot, therefore, be said to have led to any conclusion which can be accepted without further evidence.

The Theory of Commutation. By C. C. Hawkins. Pp. 81. (London: J. Tucker, no date.) Price 2*s.* 6*d.*

IN this pamphlet Mr. Hawkins enters into a complete mathematical investigation of the reactions occurring during the process of commutation in continuous current dynamos. The author first examines the case in which the contact resistance of the brushes is neglected, and then proceeds to give a complete solution of the equation for the current in the short-circuited coil, taking into account this resistance. This solution is due to Prof. Arnold and Dr. G. Mie, but our thanks are due to Mr. Hawkins for introducing it into England and for pointing out its practical bearings. Mr. Hawkins shows that the contact resistance is of the greatest importance in preventing sparking; the employment of carbon as the material of the brushes is consequently desirable, since the contact resistance of carbon is about fifteen times that of copper. Allowing for the fact that the surface needed to collect the same current must be about five times as great with carbon as with copper, the carbon brushes are still, approximately, three times as good as copper. The author also points out the other considerations affecting sparking, and goes fully into the question how it may be best avoided, both in dynamos and motors. The mathematical investigation is made clearer by the application of the results to a practical case, and by a careful explanation of the physical interpretation of the equations.

Album of Papúa. Types II. North New Guinea, Bismarck Archipelago, German Salomon Islands. By Dr. A. B. Meyer and R. Parkinson. About 550 figures on 53 plates in heliotype. (Dresden: Stengel and Co., 1900.) Price 50*s.*

THROUGH the energy and skill of Mr. Parkinson, Dr. Meyer has been enabled to publish a second album of photographs illustrating Melanesian ethnology. The present album supplements the first one, which was published in 1894, and is now out of print. The photographs are well taken, and give us instructive glimpses of native life. The short explanation of each plate is printed in German and English, and these little accounts frequently contain notes of great interest, and there are helpful references to previous publications. There is a photograph (pl. xxiii. 2) of a girl playing the "pangolo." In his admirable memoir on "The Natural History of the Musical Bow," Mr. H. Balfour gives an account of the playing of this interesting musical instrument, which differs from that described by Meyer and Parkinson, the original account of the pangolo, by Dr. O. Finsch, being insufficient. Mr. Balfour evidently read into Finsch's figure more than it was intended to convey.

Albums such as these are of very great service to students at home, as good illustrations are much more readily grasped than are long verbal descriptions, and we hope that other albums will follow in due course. This is not the first time that Mr. Parkinson's labours in ethnology have been recognised in NATURE, and we only wish that some of our British residents and traders

in Oceania and elsewhere would follow the good example of this indefatigable and public-spirited German trader.

The Story of Thought and Feeling. By F. Ryland. Pp. 219. (London: George Newnes, Ltd., 1900.) Price 1*s.*

PSYCHOLOGY is not for those who require spoon-feeding. Many, however, nowadays need a rallying-point for allusions in current literature to a fashionable science, and some would fain still perturbations aroused by the self-consciousness of their children's teachers. To such Mr. Ryland offers a little book which is clear and concrete, and as condensed as possible without loss of these qualities. He confines himself to an interesting account of certain mental phenomena, aims rather at description than explanation which can be controverted, and his book is excellent of its kind. Mr. Ryland is familiar with the most modern authorities, and presents a fascinating subject-matter attractively. Mental imagery is most successfully treated. Mr. Ryland employs the selectiveness of attention inadmissibly as an argument against any form of materialistic theory (p. 22), and he is too vague on the relation of will, self, and kindred formulæ; but his story is so far a story that it in general steers clear of controversies the solution of which lies beyond its scope. It can be confidently recommended to the public for which it caters. H. W. B.

A Primer of Astronomy. By Sir Robert Ball, LL.D., F.R.S. Pp. viii+183. (Cambridge University Press, 1900.) Price 1*s.* 6*d.* net.

WHILE in many respects this little book seems likely to provide a useful introduction to the study of astronomy, it is to be regretted that greater assistance is not given to those desirous of observing the heavens for themselves. Even without the aid of a telescope the beginner may easily make observations, more particularly of apparent motions, which will go far to encourage a real interest in the subject.

A wide range of subjects is touched upon, and most of the explanations are clear and concise. Many of the descriptive parts are also excellent. Some of the more elementary phenomena, however, as the phases of the moon, receive very scant treatment, and the principal astronomical instruments are neither illustrated nor adequately described. Eleven beautiful plates, mostly from well-known photographs, form the most notable feature of the book.

Hand in Hand with Dame Nature. By W. V. Burgess. Pp. x + 240. (Manchester: Sherratt and Hughes, 1900.)

RURAL life and scenes contemplated in an expansive frame of mind provide excuses for the publication of many pretty books. This one does not differ essentially from many others fashioned on the same model. A country scene, a general knowledge of natural history, an impressionable nature, and a certain facility in the expression of poetic sentiment, seem the chief qualifications of the contributors to literature of this kind. A preface is followed by a "prelude," a dog is "a canine friend," and its runs are "peregrinations." We also read of "larks singing in the meridian blue," the brook "which whilom rippled its pure waters over a bed of cleanest sand," "the realm of spiritual immutabilities," "the obyte of summer," and other fanciful matters. The book is not without some attractive and instructive notes on animate nature, but they are almost lost in a maze of platitudes and inconsequent remarks. The statement on p. 39 that grains of corn "have been found in Egyptian mummy-cases, from which marvellously prolific stems have been raised in this country" contains a popular belief as to the growth of mummy-wheat which has been shown over and over again to have no scientific foundation.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Eclipse Photography.

IN a previous letter (vol. lxii. p. 246) the writer called attention to the possible advantage of positive or reversed photography and development in the light in its application to eclipse work. Since that time very considerable improvement has been made in the methods, and it is now easy to develop, in direct sunlight, plates which have been somewhat over exposed. The pictures obtained in this way are as clear and sharp as any that can be obtained in the dark room by ordinary methods. But I have not been able to secure details on such plates that cannot be secured on a negative by ordinary means. In addition, the over-exposure needed in order to obtain a fine picture is not yet small enough to warrant the usefulness of reverse photography in eclipses.

In the measurement of the actinic values which are required to yield various results on the photographic plate, a discovery has been made which will be of value in the development of eclipse photographs. It has been found that a plate which has been over-exposed as much as two thousand times can be developed as a clear, sharp negative in the dark room. This can be done by the addition of four or five drops of saturated hypo solution to a two-ounce bath of hydrochinone developer. A half ounce of Cramer's mixed hydrochinone bath with an ounce and a half of water and five drops of the hypo solution in place of the potassium bromide, gives clear and brilliant negatives, but they are slow in developing. They can probably be developed more quickly by making the bath more strongly alkaline. With a normal exposure, the addition of two drops of hypo enormously retards the development. The plate may look perfectly clean for half an hour or more, but the picture will surely appear by giving it time and keeping the bath in absolute darkness. It may require an hour and a half or more to secure complete development. With experience, which may easily be obtained in the use of the hypo-developer, there is no need that any valuable photographic plate should ever be lost by over-exposure if a proper exposure has been attempted. If the plate cannot be replaced, and loss from over-exposure is possible, a trace of hypo should always be used at the start in the developer.

With the hypo developer it is possible to develop on a Cramer "Crown" plate, either in the dark room or in the light room, any exposure not in excess of one million candle-meter-seconds. The highest limit of exposure for the development of good negatives in the dark room is one which permits the development of positives in the light. A plate two thousand times over-exposed may be developed either as a positive or as a negative. FRANCIS E. NIPHER.

St. Louis, Mo., January 12.

P.S.—This communication has been made somewhat prematurely, in order to direct the attention of those who will take part in the work of the next eclipse to a matter which may have great importance. It may be that the over-exposures with which I have been dealing are less than has been stated. It is, perhaps, open to question whether a fast plate under a thin positive, and exposed in a printing frame for three-and-a-half minutes at one meter from a three-hundred-candle incandescent lamp, is two thousand times over-exposed. There is, however, no difficulty in developing such a plate as a negative.

The Jamaican Species of Peripatus.

Peripatus jamaicensis, Grabh. and Ckll., was described in NATURE, vol. xlvi. p. 514. At that time it was supposed that all the Jamaican specimens represented a single variable species, but the differences observed were considerable, so that the writer (*Zool. Anz.*, xvi. 341) later separated two "mutations," named *gossei* and *swainsonae*. M. E. L. Bouvier has of late years been making admirable studies of Peripatus and its allies, and having procured from London and Cambridge the original Jamaican specimens, he finds that there are in reality two species represented (*Q. Journ. Micr. Science*, xliii. 755). These he classifies as follows:—

(1) *Peripatus jamaicensis*, Gr. and Ckll.
(*a*) mut. *swainsonae*, Ckll.
(*b*) mut. *gossei*, Ckll.
(2) *Peripatus juliformis*, Guild., var. n. *gossei*, Bouvier.

Unfortunately, however, the type-specimen of mut. *swainsonae* had twenty-nine pairs of legs, and was *P. juliformis gossei*. This specimen M. Bouvier so identifies, but he overlooks the fact that it is the type of *swainsonae*, and must therefore bear that name. The dark variety of *P. jamaicensis*, which M. Bouvier calls mut. *swainsonae*, may be termed mut. *bouvieri*, and the proper classification will be as follows:—

(1) *Peripatus jamaicensis*, Gr. and Ckll.
(*a*) mut. *gossei*, Ckll.
(*b*) mut. *bouvieri*, Ckll. (*swainsonae*, Bouv.).
(2) *Peripatus juliformis*, Guild., var. *swainsonae*, Ckll. (*gossei*, Bouv.)

T. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., January 4.

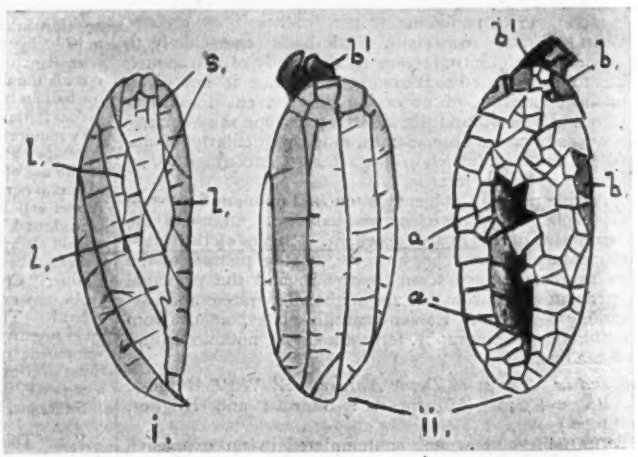
DASYPELTIS AND THE EGESTED EGG-SHELL.

A CHARMING FACT IN NATURAL HISTORY.

ANXIOUS that my pupils should see things about which they hear in the course of their class-work, I have recently lodged with the Zoological Society a standing order for an assortment of "quids," which, mostly of the nature of non-assimilable food, with occasionally a gizzard lining, are thrown out at the mouth by certain birds, snakes, and other creatures, in conformance with a habit extending to the anthropoid apes, since even the famous Chimpanzee "Sally" had acquired it (*P.Z.S.*, 1885, p. 674)—a habit most marked in certain whales, which will thus egest the whole skin of an animal devoured and flayed before being digested.

Among the first set of "castings" which I received were the two pigeons' egg-shells herein delineated, which were "thrown" by the egg-eating snake *Dasypeltis scabra* during the spring of 1900. This animal, confined to tropical Africa, shares with the Indian *Elachistodon* the unique feature of possessing vertebral "teeth," recently proved by Katharinер (*Zool. Jahrb.* Bd. xi. Anat. p. 501) to be, in the African species, true hypapophyses, toothlike but destitute of enamel, which mostly project towards or into the œsophageal lumen, through its median dorsal wall. The two snakes are members of distinct sub-families, and, in their isolation and independent occurrence, they furnish an ideal example of the principle of "convergence," by the process termed by St. Hiliare for Dasypeltis itself the "balancement" and now better known as the "substitution" of organs, as is proved for this snake by Katharinер's assertion that the reduction of its true teeth is effected during ontogeny. *Elachistodon* is unfortunately known only from two examples, and although it occurs in the Bengal area, it is unrepresented in our national collections.

Katharinер, in Dasypeltis, describes hypapophyses for each of the first thirty-four vertebræ, and of these the first twenty-six are much swollen basally, their minute pointed extremities lying each within a surrounding œsophageal lip, in such a manner as to suggest that they come into action only under pressure. The remaining eight are elongated, and with the exception of the last are converted into cutting organs, which perforate the œsophageal roof when at rest. The feeding habits of this animal have been described by Miss Durham in the *P.Z.S.*, 1896, p. 715, and she states that egestion of the shell occurs on the average one and three-quarter hours after the first seizure of the egg. No observations have hitherto been published on the egg-shell as disgorged, and unexpected interest attaches to this, from the fact that the two shells herein described differ to a marked extent in the evidence they furnish of the nature of the processes at work. Both agree only in the presence of a deep indentation (Fig. ii. *a*—*a*). As examined in the dried shell this gives the impression of a definite rent, through which the egg-contents would appear to have been discharged; but as its precise nature cannot be decided without maceration, which would lead to a sacrifice of one of the shells, I leave the settlement of this to the future. Whether it be a cut or a mere depression, it is beyond doubt due to the action of the perforating hypapophyses; for while it is limited to what would appear to be the area of apposition between these and the convex shell surface when in contact, its edges may be inrolled as under pressure from without; and the main reason I have for doubt is that in the larger egg (Fig. ii.) the shell-membrane (*b'*), ragged and torn, projects freely from the upper end, as though the discharge of its contents had been there effected. The shell-area surrounding the afore-named indentation (Fig. ii.) is in each case flattened and somewhat irregularly broken up, the whole presenting



Rough outline drawings of pigeon's egg-shells orally egested by the egg-eating snake, *Dasypeltis scabra*, to show fracture lines and limits of the incision for apparent discharge of the contents. *a*, incision; *b*, areas from which shell-fragments have been removed; *b'*, ruptured shell-membrane; *l*, longitudinal fracture lines; *s*, spiral fracture lines; *i*, non-flattened surface × 1½; *ii*, flattened and non-flattened surfaces of a second shell × 1½.

an appearance unquestionably due to pressure, but whether by contact with the anterior or posterior set of hypapophyses, it cannot at present be proved.

It is concerning the non-flattened shell-area that the conditions are most novel and interesting, for this, though brittle and subjected to a crushing action, is not, as would be imagined, irregularly broken up. The lines of fracture, in places irregular, are for the most part uniformly recurrent and equidistant. In the shell first examined they were found (*s*, Fig. i.) to be mostly longitudinally spiral and broken up in the intervening areas by cross-lines either transversely spiral or feebly transverse; and in consideration of the fact that the pigeon's egg is spirally rotated during its descent of the oviduct and as its shell is superadded, the conclusion suggests itself that the lines of fracture might be those

of a structural differentiation of the shell-substance, rendered pliable by a possible digestive action of the snake's œsophagus or buccal glands. This idea, however, is at variance with the fact that for the second shell (Fig. ii.) the chief lines are longitudinal, and the lesser, so far as they can be recognised, transverse. Of the whole series of lines, the longitudinal and longitudinally spiral are much the more marked, the lesser of the transverse series being much feebler and often incomplete—so much so that they mostly present the appearance of mere superficial scratches, visible only in certain lights, which, by thinning the shell, facilitate its distortion without breakage under pressure. Over the flattened area, however, they become actual "cracks," breaking clean through.

The question thus arises whether the main lines of fracture, if predetermined by shell-structure, may not involve the bird's oviducal wall, or whether the whole result may not be the work of the hypapophyses, under a co-ordinated muscular action of the snake's œsophagus, and it becomes necessary to inquire whether the rotation within both this and the pigeon's oviduct may not be a variable process, especially when it is found that in the shell of Fig. i., which is spirally fractured, there are three longitudinal lines recognisable (*l*,) though of variable extent.

The most conspicuous feature of the main fracture-lines is their regular recurrence and intersection at right angles—*i.e.* they are essentially cancellous. The regular recurrence of the hypapophyses suggest an obvious association with them, but this can only be determined on the death of the snake. If, as seems most likely, the distances between these and the fracture-lines will be found identical, there will remain no question as to how the latter arise. Spiral rotation of the egg beneath the anterior hypapophyses might well produce, under pressure, the spiral and transverse lines of both Figs. i. and ii. Kathariner's description of the condition of the parts, which gives us for each an elastic pad with a central stiletto, are just such as would be required to produce the result observed; and if this be due to the action of the anterior hypapophyses alone, the presence of the lines over the flattened area will be explained, by their being formed before the cutting "teeth" are brought into action.

The regularity of the fractures would seem to favour this view, and if it be correct, one can only marvel at the exquisite delicacy of the muscular apparatus concerned and its co-ordinate activity; but there still remains a difficulty in the case of the longitudinal lines, as it is hardly conceivable that the snake's œsophagus, distensible though it is, could accommodate so large an egg transversely placed.

The slight extent to which, where most fully fragmented, pieces of the shell may break away (as at *b*, Fig. ii.), is a striking feature, and it becomes the more interesting by Kathariner's discovery that the head of the intestine is so modified that it would oppose their passage should they reach it. Both the main longitudinal and spiral lines, as has been said, can be traced into the flattened shell-area, despite the fragmentation of that, and this would seem to justify the belief that the expulsion of the shell-contents must be a slow process, an inverted peristalsis, taking place during the egestive act.

The whole matter bristles with interest and suggestiveness. Thanks to Dr. P. L. Sclater, I am assured the shells which may yet be cast up by the snake now living in the Zoological Gardens, and the carcass of the animal when dead, for the further study of detail. I cannot, however, refrain from bringing to the notice of the scientific public a topic so fascinating as that herein dealt with, since it is one of those exquisite things which only organic nature reveals, and that but rarely.

G. B. HOWES.

THE LIVERPOOL MUSEUM AND PROGRESS.

OUR attention has been directed to a correspondence now taking place in the Liverpool press, *à propos* of a recent meeting of the Biological Society, at which questions were raised as to the disposal of space in the newly-erected extension of the city Museum and the rearrangement of the collections which must thereby ensue. The subject was introduced by Mr. Isaac Thompson, a past president, and continued at length by Prof. Herdman, in his capacity as the founder and leader of the Liverpool Biological School; and the undisguised theme was a protest against the non-communicativeness of the Museum Director and his committee of management, as to their intentions for the future development of their work. These gentlemen, it appears, who, with the sole exception of the Director himself, are in no way scientific, do not choose to consult Prof. Herdman and his co-workers, by whose long years of devoted labour the Liverpool School of Biologists have come to occupy a foremost position among the schools of the United Kingdom, more especially in matters pertaining to the fisheries and of economic importance. The claim which the local scientific men now raise is that their body shall be adequately represented on the Museum Board, and that immediate provision shall be made by this Board for the establishment of collections bearing on the nature and progress of oceanographic research and the fisheries, as more particularly representing the Liverpool area, regarded as a centre of local activity. And they also desire the display of objects of local interest, which shall in some measure reflect the latest advances in our knowledge of nature's operations.

The movement has been immediately taken up by the Liverpool geologists, who have also held a meeting of protest; and the general concern on the part of the combined Liverpool natural history societies is, as to whether the *régime* of the past, under which the Museum, controlled by persons mostly destitute of knowledge and experience of scientific affairs, shall remain a general emporium, having for its object the vain endeavour to fulfil the functions of a great central national museum, or whether it shall be made the centre of accumulation and display of all natural objects of local interest, supplemented only by such others as shall mark, in more especially its philosophic and educational aspects, the groundwork and recent progress in the natural history sciences. General collections from afar and costly *rarissimae* will be forthcoming so long as the exploring Liverpudlian and the enthusiastic amateur exist, while the Directorate cannot be denied the power of purchasing such things, within reason, when so minded. It is with the work-a-day aspect of the Museum, as a rate-supported institution, that advancement is now desired, and most assuredly the latter of the afore-mentioned courses is, for this, the right one, as it is that dictated by general progress in all that pertains to museum work throughout the country, and by common sense. And if this be so, the members of the Liverpool Biological Society, the older and more experienced of whom, under Prof. Herdman's guidance, have become universally recognised experts, having by their labours earned, as loyal citizens, a right of control, constitute a very suitable and competent body of men available for consultation, in itself the first necessary step for the proper strengthening of the Director's hands, if he is to be free and efficient as chief administrator.

Z. T. GRAMME.

M. ZÉNOBE THÉOPHILE GRAMME, who died last week at the age of seventy-four, was one of the pioneers of electrical engineering. He was born in Belgium in 1826, and was brought up as a carpenter; a taste for mechanics led him to attend some scientific

lectures at Liège, and subsequently he came to Paris and entered the "Alliance" factory as a workman. At this factory were built dynamos and arc lamps for lighthouse purposes, and here, as well as at the workshops of Ruhmkorff, where he also worked, Gramme managed to obtain a mastery of the principles of electric currents. The development of the dynamo, although it proceeded rapidly after the discovery of magneto-electric induction by Faraday, had not at that time attained a sufficiently high degree of perfection to give the machine then made any great industrial importance. In 1870, a few years after the discovery of self-excitation by Wilde, Gramme invented the ring armature which has since borne his name. This type of armature had been practically invented before by Pacinotti, a student at Pisa University; but Pacinotti's invention was before its time, and failed in consequence to obtain the recognition it deserved. It was reserved for Gramme, in re-inventing the ring armature, to produce a dynamo which rapidly obtained great commercial importance.

An interesting fact in connection with Gramme's armature is that the English patent was quite inadequate for so important an invention. The reason of this was that at the time the final specification was drawn up Paris was besieged, and Gramme's English agents were unable to obtain all the information they required. Gramme's machine was self-exciting, and combined good commutation with good lamination of the armature core. Also it is noteworthy that, at a time when the principles of the magnetic circuit were not understood, and when it was consequently impossible to design a dynamo mathematically, Gramme's machine had a fairly well proportioned magnetic circuit. Gramme had, without doubt, the engineering mind which is able to feel instinctively whether a machine is well designed or not. Gramme's machines were conspicuous at the Exhibition at Vienna in 1873, at Philadelphia in 1876, and at Paris in 1878 and 1881, and probably owe their success as much to the energy with which they were introduced to the world as to their great intrinsic merits.

Gramme was an Officer of the Legion of Honour and a Chevalier of the Order of the Iron Crown of Austria. In 1897 he was made a Knight Commander of the Order of Leopold, and a banquet was given in his honour at Brussels to celebrate the occasion. He died at his home, near Paris, on January 20, and was buried in the cemetery of Père Lachaise on January 23.

NOTES.

In consequence of the lamented death of Her Majesty the Queen, and as a sign of mourning, all the meetings of scientific societies announced for the latter half of last week and the whole of this week have been postponed.

The Amsterdam Genootschap ter Bevordering van Natuur-, Genees- en Heelkunde has awarded the Swammerdam gold medal for 1900 to Prof. Dr. C. Gegenbaur, of Heidelberg. This medal was instituted by the Genootschap in 1880, to be awarded every ten years to the person who in those years made important researches in the sciences cultivated by Swammerdam. It was awarded for the first time, in 1880, to Prof. Dr. C. Th. von Siebold; and the second time, in 1890, to Prof. Dr. Ernst Haeckel.

We have with deep regret to record the death of Dr. Walter Myers, which took place on January 20 at Pará from yellow fever. It will be remembered that Drs. Durham and Myers went out last June for the Liverpool School of Tropical Medicine to study yellow fever. Both these gentlemen fell victims to their devotion to science, and the latter unfortunately lost his life. The world can ill afford to lose a man of Dr. Myers' stamp, for not only did he show great promise as a scientific worker, but he had the courage and singleness of purpose to go out in the cause of science and humanity to study a very infectious and fatal disease. Many have courage to face bullets in a moment of excitement, but not all have the nobler courage to face an insidious disease with the coolness and nerve necessary for scientific inquiry.

Science announces that Dr. H. C. Bumpus, professor of comparative anatomy at Brown University, and director of the biological laboratory of the U.S. Fish Commission at Woods Holl, has been appointed curator of invertebrate zoology and assistant to the president in the American Museum of Natural History, New York City. The office of assistant to the president, Mr. Morris K. Jesup, is an important executive position, as the Museum has no scientific director. It was created last year and was filled by Prof. H. F. Osborn, who has resigned in order to devote himself more exclusively to research in vertebrate palæontology. A further reorganisation of the staff of the Museum has been made. A department of mineralogy has been formed, with Dr. L. P. Gratacap as curator, while Mr. R. P. Whitfield remains curator of geology, with Dr. E. O. Hovey as associate curator. Prof. Franz Boas and Dr. Marshall H. Saville have been made curators, the former of ethnology and the latter of Mexican and Central American archæology, though Prof. F. W. Putnam retains the head curatorship in the department of anthropology. In the department of mammalogy and ornithology, Mr. Frank M. Chapman has been made associate curator.

A discussion on the occurrence and detection of arsenic in manufactured products has been arranged for the next meeting of the Society of Chemical Industry, to be held on February 18.

The Anatomical Society has undertaken to supply the slips requisite for indexing the literature in human anatomy published in Great Britain and Ireland for the International Catalogue of Scientific Literature, which has been set on foot under the auspices of the Royal Society. For this purpose a committee has been appointed, consisting of Prof. Thane, Dr. Arthur Robinson, and the secretary of the Society (Dr. A. Keith).

At the recent conference of German biologists, held at Berlin, says the *Athenæum*, a resolution was passed calling the attention of the Imperial Government to the importance of establishing five floating stations on the Rhine for the purpose of biological investigation. Great stress was laid on the practical advantages which pisciculture would derive from these establishments, and it was resolved that if the Government failed to provide the necessary funds, an appeal should be made to the States of Baden, Bavaria, Alsace-Lorraine, Hesse and Prussia.

The lectures at the Royal Institution of Great Britain will be resumed on Tuesday, February 5, when Prof. J. A. Ewing will deliver his third lecture on "Practical Mechanics (Experimentally Treated)—First Principles and Modern Illustrations"; and on Wednesday, February 6, Prof. R. K. Douglas will deliver his second lecture on "The Government and People of China." The Friday Evening Discourse, on February 8, will be delivered by Prof. G. H. Bryan, his subject being "The History and Progress of Aërial Locomotion."

We learn from the *Times* that the question of the protection of Stonehenge from further damage was discussed at a recent meeting of the council of the Society of Antiquaries, when a resolution was passed offering to co-operate with the owner of this ancient monument, Sir Edmund Antrobus, for its protection, and suggesting that a scheme might be arranged with that object in view. A copy of the resolution has been forwarded to Sir Edmund Antrobus, and his reply will be considered at the

next meeting of the Society. The general opinion in Salisbury and district is that Stonehenge ought to be purchased by the nation, but the price which was mentioned some time ago is regarded as too great.

THE Right Hon. R. W. Hanbury, M.P., President of the Board of Agriculture, has appointed a committee for the purpose of conducting experimental investigations with regard to the communicability of glanders under certain conditions, and as to the arresting and curative powers, if any, of mallein when repeatedly administered. The committee will consist of:—Mr. A. C. Cope, chief veterinary officer of the Board of Agriculture (chairman); Prof. J. McFadyean, principal of the Royal Veterinary College; Mr. William Hunting, one of the veterinary inspectors of the London County Council; Mr. J. McIntosh McCall, assistant veterinary officer of the Board of Agriculture. Mr. A. H. Berry, of the Board of Agriculture, will act as the secretary to the committee.

IT is proposed in Dundee to erect a granite monument over the grave of James Bowman Lindsay, in the Western Cemetery of the city. Lindsay was a very remarkable man, whose memory should not be permitted to fade. He was born in 1799, and taught electricity, magnetism and other subjects in Dundee for many years, dying there about forty years ago. In 1834 he foresaw that "houses and towns will in a short time be lighted by electricity instead of gas, and machinery will be worked by it instead of steam." This prediction was the result of his own observations of effects produced by the electric current, and not merely imaginative suggestions. In 1854 Lindsay transmitted telegraphic signals through water electrically; and when the British Association visited Aberdeen in 1859, he demonstrated the success of his method by transmitting signals across the harbour. He also read a paper upon it, entitled, "Telegraphing without Wires." Sir John Leng has set on foot the scheme to commemorate the genius of Lindsay by a suitable memorial, and there should be no difficulty in raising the modest amount required for that purpose.

ON Saturday night and Sunday last the metropolis, and indeed all parts of the British Islands, were visited by a storm of great severity. The storm approached from the Atlantic so rapidly that very little notice of its appearance was visible a few hours previously. On Saturday morning the centre of a large depression which had passed to the north of Scotland lay over the north of Sweden, and the only indication of the approach of another serious disturbance was that the wind in the south-west of Ireland showed no inclination to veer beyond west. But the telegraphic reports received by the Meteorological Office showed that in the course of Saturday night the wind had rapidly increased, and on Sunday morning the centre of the storm lay near the north of Scotland. Its influence was felt as far as the south of France, and without doubt far to the north of Scotland. The gusts were very violent, and caused much damage to trees and buildings, the pressure at Greenwich amounting to 34·4 lbs. on the square foot about noon on Sunday, which is equivalent to force 11 of the Beaufort notation. By Monday morning the centre of the disturbance lay over the Baltic, but the interruption to telegraphic communication was so great that scarcely any reports from Northern Europe reached this country in time to be available for the ordinary weather forecasts. Smart showers of hail, snow and rain occurred in most parts of the country.

THE Shanghai Meteorological Society has published its seventh annual report, containing much useful information relating to the atmospheric conditions and movements in the far East. As an appendix to the report an atlas is published showing the mean isobars and the mean directions of the wind for each of the six winter months. The number of stations in the Chinese Empire is too limited to allow of precise information being given, but all that was available, relating to the sea and adjacent shores, has been collected and carefully collated. The average number of storms varies from two in October to four in November, December and January, and five or six in February and March. The general direction of the storm track is E.N.E. with a tendency to bend to N.E. The violence of the storms seldom attains the intensity of a true hurricane; force 10 or 11 of the Beaufort scale is seldom recorded. The report is drawn up by the Rev. A. Froc, S.J., director of the Zi-ka-wei Observatory.

MR. W. MCDOUGALL contributes to *Mind* (January 1901) some new observations in support of Thomas Young's theory of colour-vision. The author has attempted a re-examination of the fundamental and comparatively simple phenomena of vision, and he describes in some detail certain phenomena which he designates "the complete fading of visual images" and "the mutual inhibitions of visual images." The author is unaware of any previous mention of these phenomena, and he applies the knowledge derived from their study to an exhaustive examination of the question of a separate black-exciting process, comparable to the processes that excite the sensations of colour. It is shown that the assumption of such a process is unnecessary and groundless.

A SHORT time ago we noticed a paper, by Signor C. Viola, on the law of rationality of indices in crystallography. A much more exhaustive examination of the actual basis of the thirty-two classes of crystals is now given by Mr. William Barlow in the *Philosophical Magazine* for January. Mr. Barlow's proofs are based on the fundamental assumption of a molecular structure combined with a suitable definition of homogeneous structure. This definition implies the existence of points distributed evenly at regular intervals through the mass, such that the aspect of the structure, viewed from all such corresponding points, is the same, but that an inferior limit to the distance between corresponding points always exists. The method of arriving at the thirty-two classes combines some of the arguments used by Sohncke with some of those used by Gadolin and others, and the paper includes a discussion of Haüy's law.

SOME new experiments by M. G. Sagnac on the transformations of Röntgen rays by matter are summarised in No. 157 of the *Bulletin* of the French Physical Society. The study of the electric action of the secondary rays emitted by a body affords a test of the presence of small quantities of relatively active substances such as copper, iron, aluminium. Hence, also, a method of searching for new elements. The energetic absorption of the more active rays from such a metal as platinum in the first few millimetres of adjacent air has been verified directly by rarefying the air surrounding the metal. Finally, a pencil of Röntgen rays discharges a conductor even when it does not pass through the portion of air acted on by the electric field of the conductor. It is sufficient that the rays shall traverse a portion of air separated from the field of the conductor by a Faraday screen (such as a metal gauze), and that there shall be a field of force in the part traversed, of like sense to that due to the conductor. If the charge of the conductor is reversed in sign, the rate of discharge is altered in the ratio of 1 to 10 or 20, but in the absence of the field in the second region no such change takes place. M. Sagnac's explanation of the phenomena is that the ions produced in the second region acquire, under the influence of the external field, sufficient kinetic energy to carry them through the openings of the screen into the region surrounding the conductor.

THE melting-point of gold is an important fixed point in pyrometry, and its exact determination has been attempted by several observers. In this country the electrical resistance pyrometer has been regarded as the most trustworthy instrument, the mean result obtained by its use being given by Messrs. Heycock and Neville as 1061·7° C. In the January number of *Wiedemann's Annalen* there is a further paper on this subject by Messrs. L. Holborn and A. Day. These observers prefer a thermo-couple that has been directly standardised against an air thermometer as their measuring instrument. In their previous papers these authors have described a method in which the melting-point of a small piece of gold wire is determined. On account of the possibility of the result being influenced by the minute amount ('03 gram) used, it appeared desirable to redetermine the constant by the crucible method. The temperature of 450 grams of solidifying gold was measured with a thermo-couple in crucibles of graphite, porcelain and clay, the atmosphere above the fused metal being either air, carbon dioxide, or oxygen. The mean result was 1063·5° C. The same sample of gold gave 1063·9° C. by the wire method.

THE Board of Trade has received, through the Foreign Office, copy of a memorandum by H.M. Consul at Milan respecting an electrical smelting process carried on in North Italy under Captain Hassano's patent. The memorandum states that the feature of Captain Hassano's process is the substitution, in the smelting of iron ore, of heat produced by electricity for that produced by coal, and the merit he claims for it is economy. His experiments were begun in Rome, but have now for some time been carried on, under his personal superintendence, by a company formed for the purpose, at Darfo, in the Province of Brescia, where a considerable water-power is available. At the end of last month a commission composed of five well-known scientific men spent two days at Darfo and witnessed a series of experiments. These gentlemen have now issued a very brief report to the effect that they consider the Hassano process to be industrially practical. The Consul states, however, that he has consulted several very competent authorities at Milan who have carefully followed the development of Captain Hassano's invention, and they are all of opinion that as yet no adequate proof has been furnished that the new system will not cost more rather than less than the one actually in use. Moreover, its application, with any prospect of success, appears to be dependent on the possession of a very abundant water-power, at a very low price, for the production of the electric energy, the consumption of which is enormous.

MR. J. B. C. KERSHAW'S paper on "The Use of Aluminium as an Electrical Conductor," which was read before the Institution of Electrical Engineers on January 10, contains an account of some interesting experiments made by the author on the durability of aluminium under different atmospheric conditions. The results show that the commercial aluminium at present obtainable is by no means perfectly resistent to atmospheric corrosion, but becomes seriously pitted after ten months' exposure, especially in the air of towns. Unfortunately the scientific value of the experiments is diminished by the fact that, although the aluminium used had only a purity of 99 per cent., no analysis of the samples was made. According to Moissan, pure aluminium is quite stable, but the presence of a very small quantity of sodium destroys this stability. It is to be hoped that Mr. Kershaw, in his further experiments, will carry out a more thorough investigation of this point, as it is one of great importance. The paper shows how enormously aluminium has decreased in cost in the last ten years, until it has now become, by virtue of its cheapness, a formidable rival to copper. Some interesting details are given of aluminium transmission lines which have been, or are being, erected in America, which show that country to be far in advance of England in this, as in most other, enterprises.

IN the *Victorian Naturalist* for December Messrs. Fulton and Grant record the occurrence of the European shore-crab (*Carcinus moenas*) in considerable numbers in Port Phillip. If, as seems probable, the species is introduced, it is the first instance of the intrusion of a European marine type into the Australian fauna, and the progress of the intruder will be watched with interest. To the same number Mr. D. le Souëf contributes notes on some little known Australian birds' eggs.

IN the January number of the *Zoologist* Mr. T. Southwell, of Norwich, describes a recent visit to the fish-wharf at Lowestoft, in the course of which he shows how much information is to be gleaned with regard to our fish-fauna from such an inspection. Among the uncommon captures was a porbeagle shark nearly eight feet in length. The author adds that all the animals seen at Lowestoft must not be regarded as British, mentioning the case of the so-called prawns of the genus Nephrops, large numbers of which are brought in from the North Sea.

To the same journal Mr. G. Leighton contributes an account of an extraordinary "plague" of snakes which has recently occurred in a house at Cefncaeau, near Llanelly, South Wales. During September, according to a newspaper report, the place had become a domicile for swarms of these reptiles. "They crawled over the floors, infested the cupboards, curled themselves together on the furniture, while some more aspiring members of the species climbed the stairs and luxuriated in the comforts of the bedrooms. The human occupants of the house had done their best to rid themselves of these unwelcome visitors, and had waged a war of extermination against them. The snakes continued to come, however, although, as the inspector explained, no fewer than twenty-two were slaughtered in one day." As might have been expected, the species proved to be the common grass, or ring-snake. The eggs from which the twenty-two individuals mentioned above were hatched were probably deposited by the parent behind the oven, or in a hole in the back wall. On taking down a portion of the latter wall no fewer than forty bunches, each containing thirty eggs, were discovered, all being on the point of hatching. There were thus some twelve hundred snakes in an area of a few square feet.

THE December issue of the *Agricultural Journal* of New South Wales contains the conclusion of an interesting communication by Mr. W. J. Allen on olive culture in the Colony, illustrated with seven plates showing the fruit of the various varieties that have been raised there. The author lays great stress on the importance of cultivating only such varieties as have been proved to be suitable to the Australian climate and soil, and are, at the same time, noted for their abundant yield of oil. How great is the difference in the latter respect between different strains is shown graphically by photographs of a series of equal-sized flasks containing the products of equal quantities of olives. In the case of two varieties the yield is a flask and a half, or more, whereas some of the inferior strains yield not more than one-sixth of a flask.

WE have received the fifth of the excellent series of *L.M.B.C. Memoirs* now in course of issue under the able editorship of Dr. Herdman, the present fasciculus, which is by Dr. Hickson, dealing with *Alcyonium*, the zoophyte commonly known as "dead men's fingers." The anatomy, development and physiology of this curious compound form are severally treated in considerable detail, the whole account forming a model of how such a subject should be treated. When an Alcyonium colony has all its polyps fully protruded, the whole

organism is in a state of activity; but this could not go on incessantly, and the periodical retraction of the polyps seems to mark intervals of rest. These periods of rest and activity appear to be correlated, not with night and day, but with low and high tides; and it seems probable that Alcyonium takes a rest at each low tide, that is, twice in every twenty-four hours. Owing, however, to the unsatisfactory conditions obtaining in aquaria, it has not yet been found possible to ascertain the duration of these periods of repose in a state of nature. The author adds that in a large fleshy mass like Alcyonium it is obvious that there must be some general system of circulation, and in the absence of rhythmically contractile organs it is equally obvious that such circulation must be maintained by ciliary action.

MUCH interesting and important information with regard to food-fishes is afforded by the Report of the Northumberland Sea-Fisheries Committee for 1900, edited by Mr. A. Meek. The flat-fishes, collectively, give an average of 231 in the "takes," which is a considerable improvement over the previous year; but this is almost entirely due to an increase in the number of dabs, plaice having diminished to a marked degree, while turbot have, unfortunately, become exceedingly rare along the coast. It is, however, gratifying to notice that the catch of soles shows a slight improvement over those of the two previous years. Very few floating eggs were obtained, the explanation being that the work was done in harbour during summer, and that the fringe of water near the coast is also the fringe of the great area of water outside where the spawning and hatching take place. A short statement by Prof. Brady is made with regard to the pelagic fauna obtained with the eggs, while Mr. Bulman treats of the molluscs, and the editor of the shrimp-like mysids and the curious crustaceans included under the name Cumacea. These latter may seem to have but a remote connection with fisheries; but as they contribute, directly or indirectly, to the food of fishes, crabs and lobsters, their inclusion in the Report is fully justified. The results of the hatching experiments conducted during the early part of the year show that the work of the fertilisation of the ova of ripe fishes caught by the trawlers must be done at sea soon after the capture of the fishes. An experiment in mussel cultivation has been undertaken, the results of which will be published in the next Report.

A FEW particulars concerning the bird-catching industry in the Faroe Islands are given in the *Board of Trade Journal* (January 24). Among the various species which make the isles a country of birds, the following may be specially mentioned: the guillemot, the auk, the puffin and the kittiwake. During a certain part of the summer they appear in such numbers on and around the "fowling cliffs" as to suggest resemblance to a thick snow-storm of living winged creatures. In the Faroe Isles a "fowling cliff" means a perpendicular cliff, the numerous shelves of which are covered with guillemots and auks. The puffin and the kittiwake are also often found here, but not necessarily always. The "fowling cliffs" all face towards the west—that is, from south-west to north-west. There are also perpendicular cliffs facing towards other points of the compass, but scarcely any birds are found on these. The puffin is the most important bird in the islands, and about 100,000 are caught annually. Twenty-four of these birds yield one pound of feathers. A few years ago a number of grouse were let loose on the islands, and it appears that they have thriven well on some of the northern isles, where several flocks may be seen.

A TRIPLE horizontal pendulum of the Rebeur-Ehlert type has recently been erected for the study of earthquakes at Hamburg. Dr. R. Schütt, who has charge of the instrument, has published the first of a series of monthly *Mittheilungen*, dealing with the earthquakes registered during October 1900.

IN a short paper contributed to the Roumanian Academy, and published in vol. xxii. of the *Analele*, Dr. S. C. Hepites describes the Roumanian earthquakes of 1899. They were all of slight intensity, and occurred on January 12, August 6 and 9, October 10, November 13 and December 20.

MR. JAMES MCEVOY reports on parts of Alberta and British Columbia (Geol. Surv. Canada, *Ann. Rep.*, part D, vol. xi, 1900). His observations were made in a traverse of the Yellow Head Pass route from Edmonton, on the North Saskatchewan river, to Tête Jaune Cache. Rocks of Archæan, Cambrian, Devono-Carboniferous, Cretaceous and Tertiary ages are recorded, as well as Glacial and other superficial deposits. Gold is noted in the Lower Cambrian areas, and some thick seams of coal in the Lower Laramie (Cretaceous) strata.

DR. J. F. WHITEAVES contributes descriptions of some new and imperfectly-known fossils from the Cretaceous rocks of the Queen Charlotte Islands (Geological Survey of Canada, "Mesozoic Fossils," vol. i. part 4, 1900). As he remarks, the progress of palæontological research during the fourteen years which have elapsed since the third part of his work was published, necessitates alterations in nomenclature. A fossil was previously identified as *Ammonites Beudanti*, and placed in the genus *Haploceras*: since then the Ammonite has been regarded as a *Desmoceras*, and more recently it has been referred to the subgenus *Puzosia*. Dr. Whiteaves deems it prudent to give the Canadian fossil a new specific name, so the Ammonite now stands as *Desmoceras* (*Puzosia*) *Dawsoni*. This is a good illustration of the heartrending though needful changes brought about by the detailed study of fossils. A number of new species of Mollusca and Brachiopoda are now described and figured by Dr. Whiteaves. One British species, *Inoceramus concentricus*, is recorded.

AUSTRALIA offers a wide field of work for those experienced in the industrial utilisation of vegetable products. Although the practical value of economic botany remains imperfectly understood throughout the Commonwealth, there are not wanting indications of its approaching recognition as a new and valuable source of national wealth. Recently, in New South Wales, Mr. R. T. Baker, the curator and economic botanist of the Sydney Technological Museum, appeared as a witness before a Royal Commission appointed to inquire into the condition of the western lands of the State. In the course of his examination he produced samples of eucalyptus oil in various stages, extracted from trees in the eastern portions of New South Wales, and stated that the colony now produces eucalyptus oil of the highest quality, fully equal to the best in the market. He said that a large amount of research has lately been made in connection with the flora of that part of the parent State, with very valuable results. For instance, myrticolorin, a new dyeing material, has been obtained from the leaves of the red stringy bark, in addition to the valuable oil extracted from the same source. Out of trees and shrubs in the eastern portion of the State, Mr. Baker has, with the assistance of his staff, extracted camphor, perfumes (such as otto of roses, ionone and cinnamon), dyes, peppermint and cajuput—oils which ought now to be pushed on the market. New South Wales can also compete against India and Bulgaria with its geraniol extract. Mr. Baker's evidence went to show that the vegetable products of the western, or dry country, in New South Wales, possesses an economic value not inferior to those of the eastern or coastal districts. It may be mentioned that there are in the west, as in the east, many millions of eucalyptus trees of various

kinds, the trees and shrubs from which oils, resins, dyes, tans and other products can be obtained being several hundred in number.

THE current number of the *Proceedings* of the Royal Society contains a paper of much interest to all who are devoted to the canine race. It describes Dr. Copeman's successful endeavours to isolate the micro-organism responsible for distemper in dogs. The investigations here recorded are a continuation of work begun some ten years ago by the late Everett Millais at St. Thomas's Hospital. Dr. Copeman has now isolated a small cocco-bacillus, growing readily on most of the ordinary culture media at the body temperature, from the exudations from the lungs, the tracheal mucus, and from the nasal secretion of dogs suffering from distemper. A cubic centimetre of a broth-culture of this microbe, injected beneath the skin of the abdomen in a dog weighing 7 kilograms, is sufficient to induce an attack of distemper terminating fatally in about a week from the date of inoculation. A vaccine has also been prepared which Dr. Copeman states can protect dogs against attacks of distemper. This vaccine is procured by heating a broth culture of the bacillus at 60° C. for half an hour, and then adding a small quantity of carbolic acid. An injection of 2 cubic centimetres of such vaccine was apparently sufficient to protect fox-terrier pups weighing about 1½ kilograms when exposed to distemper infection. How long this immunity is retained by dogs has not yet been ascertained, but information on this and other important points connected with this discovery may shortly be expected, as Dr. Copeman tells us that a series of tests on a large scale are in process of being carried out by dog-breeders in this country, as well as in Germany and America.

WE are very favourably impressed with the first number of the *Journal of Hygiene*, which has just been issued. Messrs. Nuttall, Cobbett and Strangeways-Pigg contribute a paper, illustrated with maps, on the geographical distribution of *Anopheles*, the malarial mosquito, in England, and Messrs. Nuttall and Shipley the first part of a paper on the structure and biology of the same insect. Species of *Anopheles* seem to have been met with in all the districts examined, and not only in those where malaria was formerly prevalent. Dr. Klein, dealing with the pathogenic microbes of milk, has found the tubercle bacillus to be present in 7 per cent. of the samples examined, a figure which accords well with our own experience. Dr. Legge discusses industrial lead poisoning, and Dr. Newsholme the utility of isolation hospitals in diminishing the spread of scarlet fever. Dr. Haldane describes an apparatus for the rapid determination of carbonic acid in air. The apparatus is quite portable (the inclusive weight being only about six pounds), and has an accuracy of 0·5 vol. per 10,000. Dr. Haldane also contributes a paper on the red colour of salted meat, and finds it to be due to nitric-oxide-hæmoglobin. This is formed by the action of a nitrite on hæmoglobin in the absence of oxygen and in the presence of reducing agents, the nitrite resulting from the nitre in salting by reduction, probably through the agency of bacteria. When boiled it is changed into nitric-oxide-hæmochromogen. Messrs. Lorrain Smith and Hoskins find that ethylene does not contribute to the poisonous action of coal gas. Dr. Ritchie discusses the artificial modifications of toxins under the influence of acids and alkalies. The *Journal*, which is edited by Drs. Nuttall, Haldane and Newsholme, is to be issued quarterly, and is published by the Cambridge University Press. The present part is illustrated with figures and diagrams in the text, with a double plate illustrating the structure of *Anopheles*, and with a beautiful coloured plate of *A. Maculipennis*.

THE *Reliquary and Illustrated Archaeologist* has its usual well-illustrated articles on various matters of antiquarian interest. We need only call attention to a paper by Mr. W Heneage Legge on some churches in the Hundred of Willingdon in Sussex; one by Mr. J. K. Floyer on "A thousand years of a Cathedral Library" (Worcester). Miss Florence Peacocke draws attention to needlework maps, which were sometimes veritable works of art. John Schorne, a mediæval worthy, is the subject of a paper by Mr. T. Hugh Bryant. This popular preacher of the early fourteenth century was accredited a saint by public opinion because he "conjured the devil into a boot." This may be the origin of the popular tavern sign "The Boot," and may also have given rise to the toy known as "Jack-in-the-box."

IT has been stated that the inhabitants of the Mentawei Islands, which lie off the west of the coast of Sumatra, are more nearly allied to the Polynesians than to the Malays; but in a beautifully illustrated account of these islanders in *Globus*, Mr. C. M. Pleyte denies this resemblance, in which he is certainly corroborated by the illustrations, and states that they are allied to the Battak. Mentawei is derived from the Malay *matäu*, "man," pronounced locally *matawi*. The natives call themselves Tschakalägät. The men and women are tattooed in straight and slightly curved lines, and occasionally bird designs, on various parts of the body, but the men are more ornamented than the women; it is a necessary preliminary to marriage. It is interesting to note the bow and arrow is employed; the arrows used in warfare are poisoned; the blow-pipe is unknown. The religion appears to be shamanistic; men and women may be shamans (Pleyte terms them "priests"). There are numerous prohibitions, or taboos (*punän*). Divination is performed by an examination of the viscera, especially the stomach, of pigs and fowls. The paper is a valuable record of the ethnography of a people practically unaffected by external influence.

THE Canadian Institute could not have chosen a more appropriate way of commemorating the first fifty years of its history than by the publication of the fine memorial which forms vol. vi. of the *Transactions* of the Institute. The papers in the volume cover a wide field of scientific activity, and do honour to Canada. Sir Sandford Fleming, who was the first secretary and the real founder of the Institute, should be gratified at its growth and influence. The Institute has encouraged scientific study and investigation, and their applications to practical results. It has placed a vast amount of varied knowledge at the disposal of the public, and its recommendations have for many years been received with respect in the official as well as the scientific worlds. One subject of great interest, which first engaged the attention of the Institute twenty years ago, and with which the name of Sir Sandford Fleming is prominently associated, is the zone system of time-reckoning. On the action taken by the Institute, a discussion was inaugurated which extended eventually to Great Britain, and afterwards to all civilised nations, with the result that the essential principles of the system recommended have been adopted on all the five continents. Countries are being brought into the zone system one by one, even though all of them have not adopted the twenty-four hour notation. In other matters the Institute has taken the lead, and has contributed in no small degree to the increase of knowledge in letters, art and science in the Dominion of Canada. We can only mention a few of the subjects dealt with in the volume, namely, the geological history of Lake Superior, the decipherment of the hieroglyphic inscriptions of Central America, the magnetic influence of the sun on the earth and on comets, the structure, microchemistry and development of nerve-cells, the cytology of non-nucleated organisms, the anatomy of the orang-outang, and the morphology of the central cylinder in the angiosperms.

THE following lectures will be delivered during February at the Royal Victoria Hall, Waterloo Road, at 8.30 p.m. :—February 5, "Germs, Our Friends and Foes," by Mr. J. E. Purvis; February 12, "The Eastern Hemisphere," by Mr. E. J. Garwood; February 19, "An Old English Chemist of the Seventeenth Century," by Dr. Donnan; February 26, "Life of the Natives of Sarawak," by Prof. Haddon.

THE new volume of "The Englishwoman's Year Book and Directory for 1901" (A. and C. Black) has been overlooked until now. The value of this annual lies in the fact that it is a guide to spheres of activity open to women, and a summary of women's contributions to intellectual progress during the past year. The scientific summary is not complete, but it serves to show that women are assisting in the advancement of many departments of natural knowledge.

THE only journal in the world devoted entirely to the study of ophthalmological refraction is the *Dioptric and Ophthalmometric Review*, published for and by the Council of the British Optical Association. In addition to the articles, abstracts and notes of special value to opticians, the review contains contributions of interest to all students of optical science. We notice, for instance, descriptions of recent optical patents, and the questions set at the examination of the British Optical Association in December.

THE additions to the Zoological Society's Gardens during the past week include three Martinican Doves (*Zenaida aurita*) from the West Indies, presented by Mr. D. Seth Smith; a White-backed Piping-Crow (*Gymnorhina leuconota*) from Australia, presented by Miss Crowder; a Peregrine Falcon (*Falco peregrinus*), European, presented by Mr. Alfred Ficken; a Greater Black-backed Gull (*Larus marinus*), European, presented by the Hon. Mrs. Barnett; a Himalayan Monkey (*Macacus assamensis*) from Northern India, a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, a Two-spotted Paradoxure (*Nandinia binotata*), a Grey Parrot (*Psittacus erithacus*), a Shining Weaver Bird (*Hypochera nitens*) from West Africa, a Barbary Wild Sheep (*Ovis tragelaphus*) from North Africa, a Barbary Falcon (*Falco barbarus*) captured in the Red Sea, nine Ceylonese Terrapins (*Nicoria trijuga*) from India, deposited; a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY.

Feb. 1. 6h. 32m. to 7h. 18m. Moon occults D.M. +17°, 1596 (mag. 5·6).
2. 17h. 20m. to 17h. 42m. Moon occults A^1 Cancri, (mag. 5·6).
2. 18h. 57m. to 19h. 47m. Moon occults A^2 Cancri, (mag. 5·8).
3. 14h. 34m. to 15h. 37m. Moon occults ω Leonis, (mag. 5·6).
9. 17h. 38m. to 18h. 53m. Moon occults B.A.C. 4700 (mag. 5·3).
14. Venus. Illuminated portion of disc = ·949, of Mars = ·997.
14. Saturn. Outer minor axis of outer ring = 15″·08.
14. 17h. Jupiter in conjunction with the moon. Jupiter 2° 51′ S.
14. 19h. 7m. Jupiter's Satellite IV. in conjunction N. of the planet.
15. 11h. 20m. Minimum of Algol (β Persei).
18. 8h. 9m. Minimum of Algol (β Persei).
19. 10h. Mercury at greatest elongation, 18° 6′ East.
20. 1h. Mercury in conjunction with the moon. Mercury 3° 29′ S.
21. 6h. 54m. to 7h. 51m. Moon occults 51 Piscium (mag. 5·7).
21. 18h. Mars in opposition to the sun.
22. 10h. 20m. to 11h. 7m. Moon occults π Piscium (mag. 5·6).
24. 16h. 20m. to 19h. 13m. Transit of Jupiter's Satellite III.

BROOKS' MINOR PLANETS.—Referring to the recent note in NATURE (January 3) announcing the discovery of three new minor planets near to Eros, Herr Kreutz publishes, in the current issue of the *Astronomische Nachrichten*, Bd. 154, No. 3682, a telegram from Prof. E. C. Pickering, of Harvard College, saying: "Brooks' asteroids not confirmed on simultaneous plate; stars near position given."

BRORSEN'S COMET.—In the *Astronomische Nachrichten* (Bd. 154, No. 3681), A. Berberich gives an ephemeris to facilitate the search for the expected return of Brorsen's Comet this year.

Ephemeris for 0*h. Berlin Mean Time.*

1901.	R.A. h. m. s.		Decl. ° ′ ″
Feb. 1	18 59 8	...	+ 6 11·4
3	54 12	...	7 15·3
5	50 14	...	8 7·4
7	47 6	...	8 49·9
9	44 39	...	9 24·7
11	42 48	...	9 53·5
13	18 41 26	...	+10 17·4

EPHEMERIS FOR OBSERVATIONS OF EROS.

Ephemeris for 12*h. Berlin Mean Time.*

1901	R.A. h. m. s.		Decl. ° ′ ″		Mag.
Feb. 1 ...	3 43 52·25	...	+24 52 16·6		
3 ...	51 13·94	...	24 3 56·7	...	8·6
5 ...	3 58 38·03	...	23 16 0·1		
7 ...	4 6 3·97	...	22 28 28·6	...	8·6
9 ...	13 31·30	...	21 41 24·2		
11 ...	20 59·64	...	20 54 48·9	...	8·7
13 ..	28 28·61	...	20 8 44·7		
15 ...	35 57·91	...	19 23 13·0	...	8·8
17 ...	43 27·24	...	18 38 15·7		
19 ...	50 56·35	...	17 53 54·5	...	8·8
21 ...	4 58 24·94	...	17 10 10·4		
23 ...	5 5 52·72	...	16 27 4·3	...	8·9
25 ...	13 19·36	...	15 44 37·2		
27 ..	5 20 44·55	...	+15 2 49·5	...	8·9

ELLIPTIC ELEMENTS OF COMET 1900 *c*.—HERR H. KREUTZ has computed the following elliptic elements of Giacobini's Comet (1900 *c*) from the determinations of position made on 1900 December 24. 28, and 1901 January 14. (*Astronomische Nachrichten*, Bd. 154, No. 3682).

Epoch 1901 *Jan.* 14, *Berlin Mean Time.*

$M = 6° 45′ 47″·0$
$\omega = 171\ 29\ 10·6$
$\Omega = 196\ 32\ 33·8$ } 1901·0
$i = 29\ 52\ 16·9$
$\phi = 47\ 52\ 35·5$
$\mu = 551″·914$
$\log a = 0·558287.$

The following ephemeris by J. Möller is given in the same journal:—

Ephemeris for 12*h. Berlin Mean Time.*

1901.	R.A. h. m. s.		Decl. ° ′		Br.
Feb. 2 ...	2 22 4	...	−18 11·6	...	0·32
6 ...	2 37 29	...	17 9·6	...	0·28
10 ...	2 52 10	...	16 6·4	...	0·24
14 ..	3 6 10	...	15 3·0	...	0·21
18 ...	19 33	...	13 59·8	...	0·19
22 ...	32 21	...	12 57·5	...	0·17
26 ...	3 44 40	...	−11 56·8	...	0·15

Observations of the Comet by R. G. Aitken with the 36-in. Lick refractor showed it as irregular in outline, with a condensation south—preceding the centre, and a small fan-shaped extension in the north—following quadrant.

REFRACTION WITHIN TELESCOPE TUBE.

IT has been supposed that the difference between the zenith-distance of a star obtained by direct observation and that obtained by observing it reflected in a pool of mercury—as it is not fully explicable as the result of the flexure of the telescope-tube—is partly to be accounted for as the result of abnormal refraction in the neighbourhood of the instrument, owing to varying air-temperatures in the room. It is *within the tube of the instrument* that these things are to be looked for.

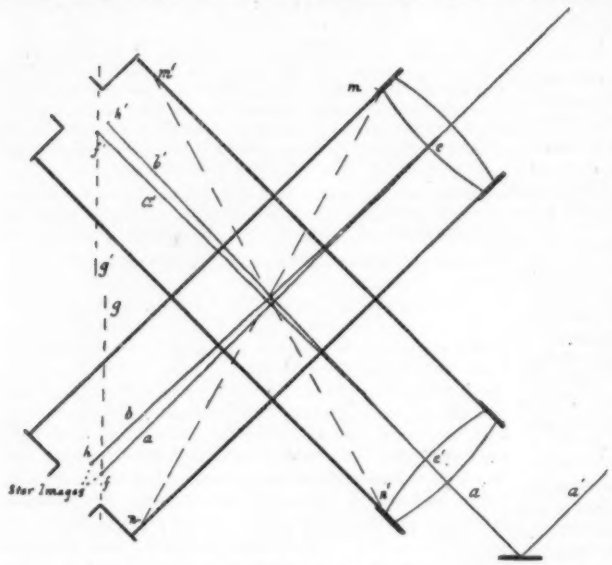


FIG. 1.—*a*, *a'*, Rays normally refracted by horizontal stratification of air. *b*, *b'*, Rays refracted by stratification of air parallel to *mn*, *m'n'*, (inverted refraction). *mn*, *m'n'*, Equal-density surfaces when upper side of tube is cooled.

The air within a room where there is no powerful source of heat and where currents are caused by open shutters, &c., must be very nearly uniform in temperature; neither would it prove the contrary to obtain varying readings of the thermometer within the room, such readings being much affected by radiation from the walls, &c. On the other hand, the air within the telescope-tube must commonly be stagnant, and any cause operating to produce differences of temperature therein will do so effectually. Now in making any observation at considerable zenith distance the upper side of the tube is cooled by radiation, while the lower is protected, and the resulting difference of temperature in the metal of the tube is communicated to the air within, to an extent depending on the time of exposure.

In the diagram (Fig. 1) showing the telescope in the two positions of observing—direct and reflex—the rays *a*, *a'*, are normally refracted and convex upwards, as they would be with horizontal stratification of the air. At any two points at the same level these rays (supposed from the same star) have the same inclination to a vertical line; therefore the zenith distances that would be observed with such refraction (angle *e*, *f*, *g* direct and *e'*, *f'*, *g'* reflex) would be the same—neglecting flexure and the difference of latitude between the trough and instrument. But this result depends on the supposed parallel (viz. horizontal) stratification of the air throughout the course of both rays. When there is a transverse gradient of temperature in the tube owing to the cooling of its upper side and the contiguous air within, the equal-density surfaces are inclined like *m*, *n*, *m'*, *n'*—a difference of temperature of only two-tenths of a degree Fahrenheit will make the air at *m* as dense as it is at *n* if these points differ in level by ten feet—and the stratification of the air, being no longer parallel in the two cases, two different zenith-distances will be obtained. The rays within the tube will then be convex downwards, *b*, *b'*—"inverted refraction"—and the direct observation will give a result in excess of the reflex one by twice the angle *f e h*. So if the results were only affected by this process the Reflex-minus-Direct results would be *negative*. The R – D results obtained in the Greenwich observations are commonly *positive* by reason of the flexure of the tube, and are *reduced in magnitude* by inverted refraction.

In the diagram (Fig. 2) the curve *a* shows the R – D results that would be obtained if affected by instrumental flexure only; from the formula 2(0″·80 sine zenith distance). This value 0″·80 I take to be nearly the correct horizontal flexure (see below). The curve A shows the mean results obtained for the values of R – D in the years 1892–3–4 for south stars, *reflex observation taken first*. The curve B shows the same results for north stars. The curve C shows a special series of R – D results obtained in the year 1894, all from south stars, the direct observation being made first. The differences between these curves severally and the flexure curve *a* are accounted for by the inverted refraction in the tube, and the various values of these differences for the three curves are readily explained:—

(*a*) The north-star-curve differs more from the flexure-curve than the south-star-curve does; the difference in both cases is due to the exposure of the instrument in the position directed to the star (chiefly in the reflex position); but in observing a north star the time of exposure is commonly greater than in observing a south star, as the observation in right ascension is made at the same time, and a slow moving polar star requires more time for this purpose.

(*b*) From Fig. 1 it is apparent that it is at the object-glass end of the tube that the inverted refraction is most effective in separating the star image *h* from the position *f*, where the normal refraction would place it; and of the two observing positions of the instrument, the direct one chiefly affects the object-glass end by radiation, because in this position it is near the open shutter. In the observations from which the curves A and B are deduced,

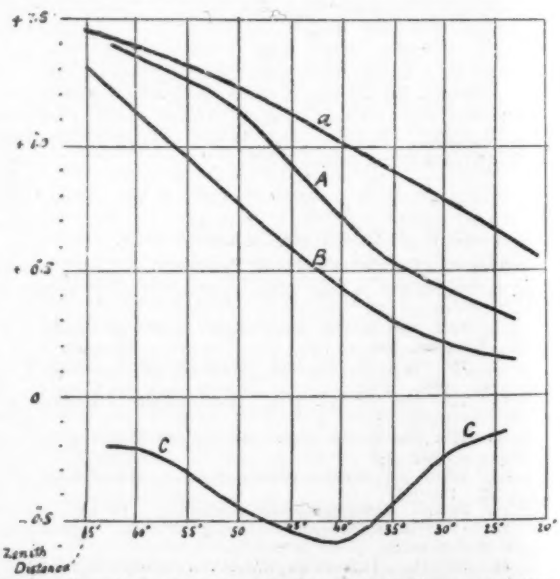


FIG. 2.—*a*, Flexure curve, 2(0″·80 sine zenith distance). A, R – D curve, south stars, reflex observation taken first. B, R – D curve, north stars, reflex observation taken first. C, R – D curve, south stars, direct observation taken first.

the reflex observation is made first, and the instrument is then turned in mid-transit to the direct position, in which the exposure is of very short duration before the observation in zenith distance is made. In the curve C, for which in each case the direct observation was made first, the exposure in the direct position would commonly be considerably greater; and the difference between this and the flexure-curve, attributable to such exposure, is accordingly much greater than the same differences for the A and B curves. Note that the difference becomes smaller under 40° zenith distance; it would be zero in the zenith in all cases.

Other instances of apparent refraction within the tube are found in the Greenwich observations:—

When the north and south collimators are alligned by looking through the holes in the telescope-cube, the collimation-error obtained differs systematically from that obtained by alligning the collimators with the telescope raised out of the way. This can only be explained thus: one side of the instrument is commonly warmer than the other at the hour (8 a.m.) when these observations are made, and the still air in the tube is affected in like manner. If we suppose the air in the spaces A and B, Fig. 3, to differ from each other 0°·5 Fahr. in temperature, and to be separated by a surface which the path of the light between the north and south collimators cuts at an angle of incidence of 80°, the light will be deflected 0″·60 of arc, and the collimation-error obtained would be in error by half this amount, viz., 0″·30,

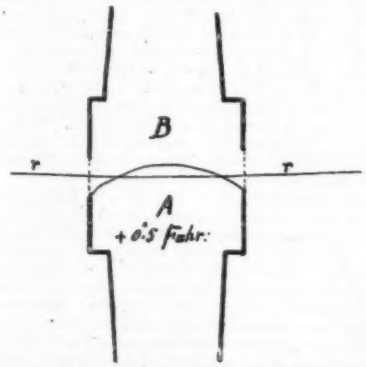


FIG. 3.—*r*, Shows path of light from north to south collimator refracted within cube of telescope when air is unequally heated.

which is about the difference between the values obtained by the two methods.

A similar discordance exists between the results for flexure of the tube formerly obtained by raising the telescope and those recently obtained by alligning the collimators through the cube; and this discordance has a similar explanation. The flexure obtained formerly, which I take to be the more correct, is about 0″·80 of arc, as employed above to explain the R – D discordance.

I conclude that means should be provided—and used—for circulating the air in the tube when any observation—whether of star, of collimation, or of flexure, or otherwise—is made with a transit circle. I would also point out that the source of error here considered is of peculiar importance from the fact that it affects, to a relatively large amount, the zenith-distances of polar-stars, and hence the deduced results for latitude. The error is eliminated in the mean of a reflex and a direct observation taken at the same time.

JAMES RENTON.

SUGAR-CANE EXPERIMENTS.

IN the fourth number of the *West Indian Bulletin*, recently noticed in these columns, many pages were devoted to communications to Dr. Morris, the Imperial Commissioner of Agriculture, from Prof. d'Albuquerque, the Island professor of chemistry, and Mr. Bovell, the agricultural superintendent, in which an elaborate plan was laid down for undertaking an exhaustive investigation into the merits of several varieties of sugar-canes. The very full details therein given should be consulted by any one desirous of mastering the significance of the facts contained in the pamphlet now issued by the Commissioner, giving a "summary of the results of the cultivation of seedling and other canes at the experiment stations in Barbados in 1900." Prof. d'Albuquerque and Mr. Bovell have read a paper on the subject before the Barbados Agricultural Society on the results of the cultivation and yield of selected seedling and other canes, and the pamphlet summarises the essential facts. It is important to remember that the experiments were throughout conducted on the ordinary system of natural cultivation, the planters themselves undertaking to set apart plots of their own plantations, so that the known and the unknown grew side by side, no exceptional treatment being recognised. In this way fairly typical results are obtained, and the results for subsequent years will, therefore, be watched with more than usual interest to see how the character of the season, as well as the quality of the soil, may affect the various canes. For the experiments seven stations were selected, representing the typical soils and climatic conditions of Barbados. Five of the stations were black soil, the other two red soil. At nearly every station there were duplicate plots of each variety, serving to show the variation to be expected with each variety from one part of the field to another. The lowest station was at an elevation of 100 feet above sea-level, the highest 910 feet, the rainfall in the growth period ranging from 56 inches to 89 inches. Fifteen selected varieties of canes were tested on the black soil estates, and ten of them on the red soil estates. For each variety the highest and the lowest yield in tons per acre in the black and the red soils respectively are given, and separate tables for black and red soils show for each cane the number of plots used for the investigation, the yield in tons per acre of canes and also of tops; the juice per cent. by mill; pounds per gallon of saccharose, of glucose and of solids not sugar; the quotient of purity of the normal juice; the juice in gallons per acre; saccharose in pounds per acre; and the sugar in tons per acre, calculated according to a formula supplied by Mr. Douglas, of the Diamond plantations, British Guiana. In the black soil B. 147 heads the list with 3·01 tons of sugar per acre, followed by B. 347 with 2·90 tons, and B. 208 with 2·83 tons, while at the bottom of the list stand D. 145 with 1·82 tons, the Burke with 1·73 tons, and the Bourbon with only 0·47 ton per acre. The White Transparent cane, which is cultivated in Barbados on a larger scale than any other cane, and may therefore be regarded as the standard for comparison, occupies a middle place with a yield of 2·41 tons per acre. In the red soil B. 208 takes first place with 3·34 tons per acre, followed closely by B. 156 with 3·32 tons and B. 147 with 3·31 tons, the lowest being B. 347 with 2·17 tons and B. 254 with 2·14 tons.

The mean results for both soils indicate B. 147 to be the best all-round cane, its yield being 27·52 tons of canes per acre, 3·1 tons of sugar and 6291 lbs. of saccharose, B. 208 occupying second place with respectively 22·55 tons, 3·02 tons, and 5443 lbs., compared with the standard White Transparent results of 20·49 tons, 2·41 tons, and 4528 lbs. A further table gives the results obtained on the three estates of "Dodds," "Pine" and "Waterford" with B. 147 and the White Transparent varieties, the means for the three estates giving B. 147 a yield per acre of 6999 lbs. of saccharose and 3·70 tons of sugar, while the White Transparent yielded 4527 lbs. of saccharose and 2·41 tons of sugar. It will thus be seen that the new seedling, B. 147, is better than the standard by more than a ton of sugar per acre. Looking to the individual and general results, the investigators consider there is a satisfactory degree of agreement under a considerable variety of conditions of culture and growth. B. 147 is regarded as the best all round seedling variety as a plant cane in Barbados, B. 208 giving promise of proving a good red soil plant and ratoon cane. Planters are advised to try, on a small scale, three or four of the varieties which have done best in these experiments, so as to be able to secure eventually the cane best suited to the nature of their particular fields and their own methods of cultivation—features which have, in their way, quite as much weight as the character of the cane itself. While B. 147 seems to be the most suitable cane for particular soils in Barbados, D. 95 appears to be the best for the different circumstances of Antigua. A private letter from Barbados, in which reference is made to the above experiments, states that the officials of the Agricultural Department seem determined on securing improved varie
that will suit each district, and will yield at least 50 per cent. more sugar than those hitherto cultivated.

TECHNICAL EDUCATION IN MANCHESTER.

IN no English city is a more sensible or more thorough provision for technical education to be found than in Manchester. Whatever standard of comparison is adopted, be it the number of students under instruction in proportion to the population, the amount of annual expenditure, the number of the schools, or the enthusiasm of its administrators and teachers, Manchester will take one of the foremost places in the educational ranks of the country. In some particulars, indeed, Manchester stands almost alone. In the arrangements which the Technical Instruction Committee of its City Council and its School Board jointly have made to secure the co-ordination of all educational efforts within their borders, and so avoid that over-lapping which is such a prolific source of loss and disappointment in many other districts, this centre of the great cotton industry may well serve as an example of a community where the first object of public men is to secure educational efficiency and not to assist the glorification of a particular board or committee.

This success is largely to be attributed to the recognition of the fact that any successful system of technical instruction must be adequately based upon a graduated supply of elementary and secondary education. It is too often imagined that technical education is independent of the work of the public elementary and the grammar schools. But in Manchester it has been for years borne in mind that it is only those youths who have received a thorough preliminary education who reap any advantage from the lectures and laboratory work of the technical school, be it never so perfectly equipped and staffed. The student of education consequently finds, when he endeavours to account for the satisfactory system of technical instruction in Manchester, that, in addition to the ordinary public elementary schools, supplying besides the three R's an elementary introduction to the principles of physics and chemistry, the School Board have provided four higher grade schools, all of them furnished with a "School of Science," and, as readers of NATURE know, the curriculum of schools of this type is eminently suitable as an introductory course for boys and girls who will later proceed to the technical school.

Adequate provision is also made for the children of a higher social status. Manchester is well provided with secondary schools. Its Grammar School and its High School for Girls both deservedly occupy high places among the public schools of the country. Manchester Grammar School, moreover, appears to have been one of the first to teach practical chemistry, for it possessed a small laboratory as long ago as 1868.

There is, too, every facility offered to bright children of the elementary schools to pass forward either to the Higher Grade School or to the Grammar School—this desirable end being secured by a sensible scheme of scholarships. By the same means a vital connection is assured, by way of the secondary schools, between the elementary schools and the Municipal Technical School and the University College.

Nor are the educational needs of youths who have begun the serious business of life neglected. All the schools, to the work of which brief reference has been made, are intended for young people who have as yet entered neither trade nor profession. But in all manufacturing districts the great mass of the workers have to complete their education by well-sustained efforts in evening classes of one kind or another. The authorities in Manchester are fully alive to this fact, and a wonderfully complete system of evening classes has grown up, in which it is interesting to note that the School Board and the Technical Instruction Committee can work together without friction and with the best results. Two sets of these classes are in vogue. First, there are the classes with which the School Board are more directly concerned—the evening continuation schools in which youngsters from twelve to sixteen years of age, who have left the public elementary school for the shop, the warehouse, or the factory, are either preparing themselves for the more advanced classes of the technical school, or are perfecting and continuing the work they did at school with a view to making themselves of greater value to their employers. Secondly, there are the evening classes of the technical school, intended for young men and women of sixteen and upwards, of which it is difficult to give an adequate idea in a few sentences. To really appreciate what is being done in such classes every winter's evening in large manufacturing districts, it is necessary to visit the schools where they are held. The determined efforts the young men and women, who, be it remembered, have generally spent a laborious day earning their daily bread, will make in order to become acquainted with the principles of science on which their work depends, or to become familiar with the canons of art they hope to apply in designing, is well calculated to inspire the hope that this country will some day take its former position in the industrial contest among the nations.

The students of the Day Technical School and Day School of Art are composed chiefly of the sons of middle class parents. In the majority of cases they do not enter seriously into the work of manufacture and distribution until after completing their studies. It is gratifying to be able to report that there are some exceptions to this rule. Some enterprising employers have made arrangements for sending certain of their employees to the technical school during the day—the employers themselves bearing the expense thereby incurred. It is much to be desired that this far-seeing policy may be more generally adopted. And there are also the scholarship-holders from the higher grade schools. Such is, in skeleton form, the system of technical education which has been gradually evolved in Manchester. The accompanying pictorial representation gives a bird's eye view of the whole arrangement. The illustration, which was prepared by Mr. J. H. Reynolds, the Director of the Manchester Technical and Art Schools, was awarded a gold medal by the International Jury of the Paris Exhibition.

Another cause of the high state of development of education in Manchester is the broad view which the Technical Instruction Committee have taken of their duties. On at least two separate occasions they have arranged for their Director, with certain members of the committee, to visit foreign countries to study other systems of technical instruction, and on another occasion they have sent him alone to visit the United States. In this way these Manchester authorities have become practically acquainted with German and American ideas of education. They have not endeavoured to follow slavishly such methods in their entirety, but have not hesitated to import notions they considered suitable for the peculiar needs of their own district.

The same committee have also taken a large part in the formation of public opinion in matters educational in Lancashire. At their instigation several conferences have been held of representatives of the numerous county boroughs in their immediate neighbourhood. Resolutions have been adopted and widely circulated urging the need of legislation to ensure that secondary (including technical) education shall be placed under the control of municipal councils, though the desirability of co-opting upon the Educational Committee an effective minority of persons of special experience in all grades of instruction, as well as of encouraging the joint action between the authorities of county boroughs and that of the administrative county have been recognised. But, if they would consider this question more from the national point of view, this enterprising local authority for education might come to a different conclusion. What is the state of affairs in south-east Lancashire? For the sake of example let Manchester be taken as a centre, and consider chiefly the technical education of the district. In this central city there will shortly be, in full working order, a technical school, erected and equipped at a cost of upwards of a quarter of a million, and really provided with accommodation enough for all the advanced technical students which the whole area under consideration could provide. Yet, within easy walking distance, there is the Salford Royal Technical Institute, also admirably organised and generously staffed, and this simply because Salford happens to be a separate borough. The other boroughs of this same area are, moreover, very close together. Stockport, with its own technical school, is within about five miles, and has a splendid train service connecting it with Manchester. Bury, Bolton, Oldham, Rochdale, and other boroughs are sufficiently near for their advanced students to be drafted to Manchester for instruction—the railway fares could easily be provided by means of scholarships. It would certainly seem as though, in the best interests of technical education, an area much larger than that of a county borough is desirable. With boroughs so near as they are in south-east Lancashire there is bound to be duplication and re-duplication of buildings and appliances. To have a school, like the new technical school at Manchester will be, engaged in elementary work, which could be done equally well at much less cost elsewhere, is to lose a grand opportunity of providing one centre at least for advanced technical instruction, of which the country stands in growing need. Experience shows, too, that the same staff cannot successfully undertake to teach crowds of elementary pupils and

also really be of assistance to the comparatively few picked students who will well repay any opportunities placed in their path for advanced study and subsequent research in applied science.

That there is no difficulty in getting students to travel, as has been suggested, is borne out by an appendix to the last report of the Manchester Committee for Technical Instruction. It is there set forth that last year there were, among the 4313 students of the technical school, no fewer than 2266 students from out-districts, of whom 18 came from Bolton, 25 from Bury, 44 from Oldham and Hollinwood, 16 from Rochdale, 348 from Salford, and 43 from Stockport, to name only a few towns from a long list in the report before us.

It is not recognised sufficiently that the technical education this country stands in need of is not elementary instruction in pure science. It has been demonstrated again and again in these columns that such teaching is really a part of every reasonable system of secondary education. When this is fully understood, the large classes in elementary science subjects will disappear from our technical schools. In their place we shall have students at work who, before entering the technical school, have become familiar with the broad principles of physical and chemical science, and who are now in a position to turn their attention to technical science—the application of pure science to the industry with which the student is connected.

Such a policy as has been indicated would make another desirable development possible. A specialisation of function on the part of schools in different towns could then be encouraged where necessary. Given a thoroughly representative authority for a sufficiently large area, and the apparent necessity of a class in every conceivable subject for each borough disappears. Each important technical school will be able to bend its efforts to solving the question of the proper form of technical instruction for one particular industry, or part of an industry. And Manchester, with the large number of great towns in its immediate neighbourhood, is an ideal district in which to begin some such sensible and economical supply of technical education. By all means let us have a generous supply of elementary evening classes in every town, but do let it be borne in mind that this work should only be regarded as preparatory. The serious need is for more centres where advanced students are looked after.

In conclusion, another instance of the enterprise of the Manchester Committee must be mentioned. At the instigation of their Director they have secured for exhibition in Manchester the fine educational collection which the American Government sent to the Paris International Exhibition. Invitations to teachers and others interested in education to come and examine this unique collection of objects are being sent far and wide. It cannot but have a good effect to show English educationists some of the ways in which America is in advance of us in this matter of training intelligent workmen. A. T. SIMMONS.

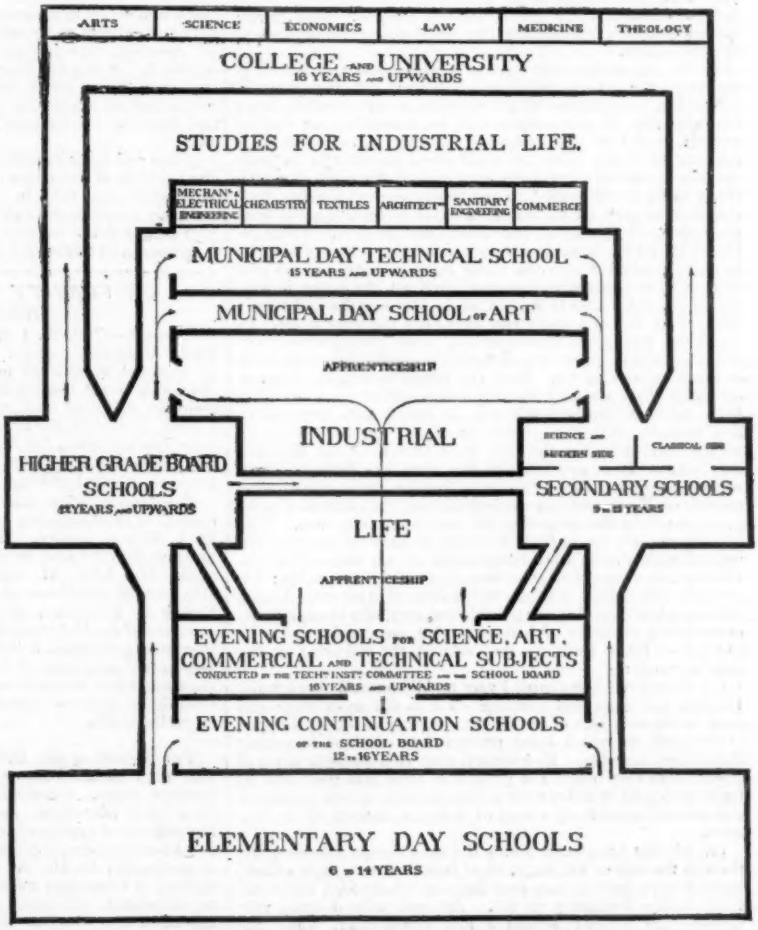


DIAGRAM ILLUSTRATING THE CORRELATION OF EDUCATION IN THE CITY OF MANCHESTER.

METHODS OF FORMATION OF HAIL.[1]

THERE are many reasons for believing that hailstones are formed in the free atmosphere by some one of several different processes, each of which may be in accord with the laws of thermodynamics:—

(1) An ascending mass of air may be so dry that it does not cool to the dew-point until far below the freezing temperature, in which case the deposit is either fine spiculæ of ice or aggregations of these into small snowflakes.

(2) If the dew-point is a little higher than the preceding, the cloudy condensation may occur at temperatures just above the freezing point, and the watery particles may be carried up a little higher and frozen into what is called frozen fog. These same particles, when driven by the wind against an object, accumulate on it as frostwork.

(3) When a rising mass of air forms a large cumulus cloud at a low level, having a rapidly ascending current in its interior,

[1] Abridged from a contribution by Prof. Cleveland Abbe to the U.S. *Monthly Weather Review*.

the latter, by its buoyancy, will rise much higher than if there were no cumulus cloud; it may pass upward into the so-called hail region, where water drops and ice particles may coexist, and still higher up into the region where only ice and snow can exist.

(4) Raindrops falling from relatively warm clouds through a very cold stratum of air below may be frozen into sleet before they reach the ground.

To these four elementary methods of forming atmospheric ice we have to add the mechanical processes by which the small particles accumulate as large hailstones. Undoubtedly much light was thrown upon this subject by the notes made by observers on Pikes Peak during the early years of the occupation of that station.

In the thermodynamic studies of Hertz and von Bezold is employed the expression "the hail stage," viz. that stage in which the temperature of 32° prevails in an ascending mass of moist air. It is supposed that the ascending air, having already cooled to the dew-point, is carrying up with it a quantity of water, either in small cloud particles or in large raindrops. When these have ascended to the level where the rising moist air is cooled to the temperature of freezing, they continue to give up to the air a little of their specific heat until they are themselves frozen into hail or sleet. There is, therefore, a thin layer of air in which this process of freezing is going on and where the rising mass of mixed air and rain is kept at a uniform temperature until all the water is converted into ice. This is spoken of by Hertz as the hail stage; below it is the rain stage and above it is the snow stage. In this latter region the ascending air, being already cooled below the freezing point, can deposit its moisture only as snow or small crystals of ice. Now the actual hailstones observed on Pikes Peak are so frequently composed of snow that has been partly melted and refrozen, or mixed with water drops and refrozen, that we cannot suppose them to have been wholly formed within the thin layer known as the Hertzian hail stage. It is more likely that they are formed partly within that and partly within the Hertzian snow stage. The memoir of Hertz assumes throughout that the changes of temperature within the ascending air are strictly adiabatic. This requires that the ascent be so slow that the drops of water carried upward maintain the same temperature as the surrounding air. But these two conditions are almost physically incompatible; it is probable that neither of them are ever realised in nature. Among other combinations that are possible and may help to explain the great variety of forms of hailstones that are caught upon the summit of Pikes Peak, we may suggest the following as the most common:—

(1) Frozen raindrops carried very rapidly upward through the Hertzian hail stage may continue on into the snow stage and grow by the accretion of snowflakes until they are finally dropped to the earth, in which latter process they continue increasing their snowy covering. If, however, they pass through the hail stage before they reach the ground in their fall, they will be found to consist of an icy nucleus surrounded by a snowy envelope and covered over all by a layer of a frozen mixture of ice and snow.

(2) Air that has ascended into the snowy stage without going through the rain or hail stage, or, at least, to a very slight extent, because of its dryness, may form large snowballs high above the Peak before beginning to fall. As such balls descend very rapidly, the interior retains a low temperature, while the exterior is slightly warmed and melted by the action of the warmer air that the snowballs find near the ground. The result is large hailstones, consisting each of a thin layer or crust of ice and a snowy mass within.

(3) In the formation of snow and hail in the midst of ascending currents of air, we must expect to notice the same phenomenon as in the formation of rain, viz. after the first condensations have taken place upon dust and foreign substances the rising mass of cloud represents dustless air in the presence of water particles, but cooled by expansion to such an extent that the air between the drops, or the ice spiculæ, is in a state of supersaturation. When this condition has become too intense, large quantities of aqueous vapour suddenly condense, rushing together into large drops of rain or large masses of snow, and carrying with them all the finer particles within their respective spheres. At the very low temperatures at which this occurs, water will hold considerable air in solution, and additional air is also included at the centre of the snowball among the particles of snow and ice. Such large snowballs are heavy enough to descend rapidly from the snowy stage, through the rain and hail stages to the ground, and in so doing they become saturated with water which recrystallises forming solid hailstones, but at the centre of the mass they still hold, confined, the air originally included in the snowball, and this is compressed under several atmospheres, as was shown in 1869, by P. Reinsch (see *Pogg. Ann.*, 1871, or *Phil. Mag.*, 1871, vol. xlii. p. 79), who observed that when such hailstones are melted under water the little bubble of air at the centre is seen to suddenly escape and expand sufficiently to demonstrate the existence of a pressure of fifty atmospheres under which it was confined. In this formation of snowballs and the resulting hail from supersaturated air within the snow stage there is an electric disturbance entirely analogous to that which takes place when great drops of rain are formed within the rain stage. In both cases violent thunder and lightning are observed just before the fall of the hail or the rain.

These and other hypotheses that might be framed relative to the methods of formation of the various kinds of hailstones must, however, only be regarded as suggestions intended to stimulate experimental and theoretical research in this direction. One cannot doubt but that the history of the formation of hail is written in its structure if we could but interpret it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. J. Sollas has been elected to a fellowship at University College. This fellowship, however, is not to be regarded as attached to the professorship of geology; the election concerns the present professor only, the College being under no obligation to his successor.

Prof. Townsend, the new Wykeham professor of physics, has come into residence, but the space intended for his laboratory will not be available until the Radcliffe Library has been transferred to its new building.

CAMBRIDGE.—The Clerk-Maxwell studentship in physics, tenable at the Cavendish Laboratory, has been awarded to Mr. H. A. Wilson, Trinity. Mr. P. V. Bevan has been appointed assistant demonstrator in physics, in succession to Prof. Townsend. Mr. J. C. M. Garnett has gained the Sheepshanks astronomical exhibition at Trinity College. Mr. L. Whibley, Fellow of Pembroke, has been appointed assistant to the secretary of the University Press Syndicate. Mr. Yule Oldham, Reader in geography, is lecturing this term on the hydrosphere, and on the geography of Central Europe. A grant of 50*l.* for the current year has been made to the Department of Pathology, towards the course of instruction in bacteriology for the diploma in public health.

THE Report of the U.S. Commission of Education for the year 1898–99 has been received. It is a volume of thirteen hundred pages, containing papers and statistics on many branches of educational activity in various countries. Among the subjects of papers of interest in connection with instruction in sciences are school gardens, by Herr E. Gang; the teaching of geography, by Dr. A. J. Herbertson and others; manual training in Germany; minor mental abnormalities in children as occasioned by certain erroneous school methods; and an annotated chronological list of American text-books on arithmetic, prepared by Drs. J. M. Greenwood and A. Martin.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, January.—Heavy rainfall of December 30, 1900. The official weather charts showed that the centre of a barometric depression lay over the middle of Ireland in the morning of that day, and that it moved southeastwards, passing Bristol in the early evening, and reaching the English Channel on the morning of the 31st. This storm was remarkable for the heavy rains which fell in the valley of the Severn and its tributaries. Falls exceeding two inches in 24 hours occurred over a broad diagonal belt from the mouth of the Severn to the mouth of the Humber, while amounts exceeding three inches occurred in a narrow strip running for about 85 miles in a northeast direction from near Bristol and Chepstow, covering an area of nearly 1000 miles.—The mild December. The mean temperature for the month in the north-

west of London was 6°·2 above the average for 40 years, and the mean maximum and mean minimum exceeded the average by about the same amount. The month ranks with the mildest of the last half century, but was equalled by December 1898, and exceeded by December 1868. The number of days (19) on which the temperature exceeded 50° is unprecedented in this series of observations, for there were only 18 such days in 1868 and 17 in 1898. The present number of this popular magazine completes the 35th volume. The magazine, while retaining its special interest in rainfall, will in future deal more fully with all branches of meteorological science than it has done in the past.

Bollettino della Società Sismologica Italiana, vol. vi. No. 5.—Seismic Greece, by F. de Montessus de Ballore. A study of the geographical distribution of earthquakes in Greece.—On the velocity of the earth-waves of the Roumanian earthquake of September 10, 1893, by C. Davison (in English). Good observations of the time were obtained at Bucharest and Oxford, the latter by Prof. Boys in his experiment on the Newtonian constant of gravitation. They give a mean surface-velocity of 3·98 km. per second.—Three-component seismometrograph for strong earthquakes, by G. Agamennone. A first sketch of a proposed instrument.—Seismometrograph with continuous-velocity registration, by A. Cancani.—Notices of earthquakes recorded in Italy (August 4 to 24, 1899), by A. Cancani, the most important being distant earthquakes on August 17 and 24.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, January 17.—Prof. Thorpe, President, in the chair.—The following papers were read:—The preparation of iodic acid, by A. Scott and W. Arbuckle. The authors prepare iodic acid by heating powdered iodine with nitric acid in a glass flask fitted with a ground-in reflux condenser and a tube by means of which oxygen is passed through the boiling liquid.—Note on isomeric change and meta-substitution in benzenoid amines, by A. Lapworth. The author explains the action of fuming sulphuric acid on dimethylaniline by means of an extension of his previously published views on the occurrence of isomeric change.—The preparation of esters from other esters of the same acid, by T. S. Patterson and C. Dickinson. It is shown that ethyl tartrate can be converted into methyl tartrate by the action of methyl alcohol and hydrogen chloride, and that methyl tartrate can be converted into ethyl tartrate by an analogous process.—Tecomin, a colouring matter derived from *Bignonia tecoma*, by T. H. Lee. The wood of *Bignonia tecoma* yields a yellow crystalline colouring matter, and is used locally as a dye for cotton and as a stain for wood.—A new method for the measurement of ionic velocities in aqueous solution, by B. D. Steele. The method consists in enclosing the liquid to be examined between two partitions of gelatine which contains the indicator ion in solution. On the passage of the current the cation of the solution is followed by the cation of the indicator, and the anion of the solution by the corresponding anion of the indicator. It is necessary in all cases that these indicator ions should move more slowly than the ion to be measured; the motion is followed by means of a cathetometer.—Metal-ammonia compounds in aqueous solution, Part ii. The absorptive powers of dilute solutions of salts of the alkali metals, by H. M. Dawson and J. McCrae.—The amide, anilide and toluidides (ortho- and para-) of glyceric acid, by P. F. Frankland, F. M. Wharton and H. Aston.

MANCHESTER.

Literary and Philosophical Society, January 22.—Prof. Horace Lamb, F.R.S., President, in the chair.—The President referred to the loss sustained by the Society through the death of Prof. Ch. Hermite, one of its honorary members.—Mr. Francis Jones showed the mode of detecting small quantities of arsenic by Marsh's, Reinsch's and Gutzeit's methods. He also showed the results obtained by the action of light on the hydrides of arsenic and antimony in contact with sulphur, constituting a further test of the presence of these metals. The result obtained from a glass of arsenical beer by Marsh's test was also exhibited, together with a sample of invert-sugar containing arsenic.—Mr. R. L. Taylor remarked upon the occurrence of arsenic in certain green tapers, of which he showed two varieties obtained from half-a-dozen samples purchased in the neighbourhood of Manchester, and demonstrated the presence of a marked quantity of arsenic in a short piece cut off from one of these tapers.—Dr. C. H. Lees mentioned a very compact formula for the circumference of an ellipse due to Mr. Thomas Muir, which is readily calculated with the aid of Barlow's tables. The accuracy of the approximation is very marked.

EDINBURGH.

Royal Society, January 7.—Prof. Copeland in the chair.—Mr. W. S. Bruce, in a paper on exploration in Spitsbergen and soundings in seas adjacent, gave an account of the work he had undertaken in conjunction with the Prince of Monaco in the yacht *Princess Alice*, and with Mr. Andrew Coats, of Paisley, in the yacht *Blencartha* (now *Pandora*). One main object of the *Blencartha* expedition of 1898 was the determination of salinities and temperatures in the Barentz Sea, an important result being the delineation of the isotherms in the successive summer months. In the expedition of 1899, the Prince of Monaco's chief aim was to survey the littoral regions to the north and north-west of Spitsbergen. The most detailed work was done in Red Bay, which they found to be very inaccurately described in the Admiralty map, and in which they had taken over 2000 soundings and 2700 angles. Many new peaks and glaciers were discovered and named, one to the south of the bay being named Peak Ben Nevis. The greatest depths in the bay were much greater than the depths in the open sea beyond, a fact which seemed to prove the glacier origin of the bay. The paper was fully illustrated by a number of lantern slides, which brought out clearly much of the geological and zoological character of Spitsbergen and Novaya Zembla.

PARIS.

Academy of Sciences, January 21.—M. Fouqué in the chair.—Notice on M. Ch. Hermite, by M. C. Jordan.—Notice on M. Adolph Chatin, by M. Gaston Bonnier.—Influence of the substitution of alcohol for sugar in food, in isodynamic quantity, on the value of the muscular work accomplished by the subject, by M. A. Chauveau. The experimental results obtained during a period of 389 days show that the partial substitution of alcohol for sugar in the food ration in a subject doing work has an unfavourable effect from all points of view, there being a diminution in the absolute value of the muscular work, and an increase in the food used up with respect to the work accomplished.—On the influence of climate upon the evolution of experimental pleuro-pulmonary tuberculosis, by MM. Lannelongue, Achard and Gaillard. Three hundred guinea-pigs were inoculated with human tuberculosis, and then submitted to varying climatic conditions, some remaining in the laboratory at Paris, others being taken to the sea, open country, mountains, &c. The advantage appeared to be with those remaining in the laboratory. Although in each lot all the animals were inoculated with the same virus on the same day, great differences occurred in the development of tuberculosis.—On the supplementary condition in hydrodynamics, by M. P. Duhem.—M. Mascart announced to the Academy the death of M. Gramme.—On the telescopic planets, by M. R. du Ligondès. An analysis of the distribution in space of the telescopic planets shows that the assumption that they represent the *débris* of a nearly flat circular ring does not explain all the facts. The more probable hypothesis would appear to be the generation of the planets by successive agglomerations of matter circulating in the interior of the solar nebula.—On the generalisation of a theorem of M. Picard, by M. S. Kantor.—On a theorem in the calculus of probabilities, by M. A. Liapounoff.—On the liquefaction of gaseous mixtures. Variation of the concentrations of the two co-existent liquid and vapour phases along the isotherms, by M. F. Caubet. It is shown that any mixture of CO_2 and SO_2 which, at 66°·3 and under a pressure of 57·6 atmospheres, can give two co-existing phases, will give a liquid phase of concentration 0·70926, and a vapour phase of concentration 0·33238.—On some properties of sodium peroxide, by M. de Forcrand. The author points out that the method of preparation of hydrated sodium peroxide, given by M. Jaubert in a recent number of the *Comptes rendus*, is identical with that published by Prof. Vernon Harcourt forty years ago.—On the combinations of ammonia with aluminium chloride, by M. E. Baud. The author's results differ from those previously obtained by Persoz and Rose. At least four stable compounds exist, $Al_2Cl_6.2NH_3$, $Al_2Cl_6.10NH_3$, $Al_2Cl_6.12NH_3$, and $Al_2Cl_6.18NH_3$. The first of these distils without decomposition at 450° C.—On the isolation of yttria, ytterbium, and the new erbium, by MM. G. and E.

Urbain. The crude earths from gadolinite are converted into ethyl sulphates. After ten crystallisations the mother liquors contain only the three elements yttrium, erbium and ytterbium, with perhaps a trace of thorium. These were further separated by the fractional decomposition of the nitrates by heat, which, in the absence of earths of the gadolinium group, gives a very satisfactory separation.—On an arsenide and chloro-arsenide of tungsten, by M. Ed. Defacqz. The interaction between hydrogen arsenide and tungsten hexachloride is analogous to that with the corresponding phosphorus compound, two compounds of the composition WAs_2 and W_2AsCl_6 being isolated.—On nitrofurfurane, by M. R. Marquis. By allowing anhydrous nitric acid and furfurane in acetic anhydride solution to react at -5° C., a nitrofurfurane can be obtained. The exact position of the nitro-group is not yet determined.—The absorption spectra of the indophenols, by M. Paul Lemoult.—On some new organometallic compounds of mercury, by MM. Auguste Lumière, Louis Lumière, and Chevrotier. When alkali phenol disulphonates react with mercuric oxide, compounds are formed of great solubility, and presenting some peculiar reactions, not being precipitated by soda, hydrochloric acid, or ammonium sulphide. Their taste is purely saline, and not metallic as is usual with mercury salts. The solutions, however, possess great antiseptic power.—On the mechanism of diastatic reactions, by M. M. Hanriot. By studies on the ferment lipase it is shown that the ferment, when attenuated by a chemical action, may regain its original activity, and also that the action of lipase upon acids and ethers appears to be a chemical combination governed by the ordinary laws of dissociation.—On the plurality of the chlorophyllines and on the metachlorophyllines, by M. M. Tsvett.—On a pseudo-agaric acid, by MM. Adrian and Trillat. The body extracted from agaric by alcohol does not appear to be a true acid, and when pure is without special physiological properties.—Transformation of creatine into creatinine by a soluble dehydrating ferment in the organism, by M. E. Gérard.—Modes of formation and preparation of propylbenzene, by M. F. Bodroux. Normal propylbenzene is formed along with other products by the interaction of benzene, trimethylene bromide and aluminium chloride.—Filtration of air by the soil, by M. Auguste Gérardin.—On the *rôle* of the chlorophyllian function in the evolution of terpenic compounds, by M. Eug. Charabot. Any influences which increase the vigour of the chlorophyll function in plants also appears to favour the production of the ethers of terpene alcohols.—On the chemical composition of the coffee from Grande Comore, by M. Gabriel Bertrand.—Action of mucus upon the organism, by M. M. Charrin and Moussu. Fresh mucus possesses poisonous properties when injected into the blood.—Radiopelvigraphy and radiopelvimetry at long range, by M. Henri Varnier.—The sponges of the Belgian Antarctic expedition, and the bipolarity of the fauna, by M. E. Topsent.—Origin of the pigment in Tunicates. The transmission of the maternal pigment to the embryo, by M. Antoine Pizon.—A new theory of chromatic adaptation, by M. Georges Bohn.—Researches on the structure of some of the lower fungi, by M. Guilliermond.—Apparent symmetry in crystals, by M. Fréd. Wallerant.—On the origin of the gold in Madagascar, by M. A. Lacroix.—On the age of the eruptive rocks of Cape Aggio, by M. Leon Bertrand.—The dômes of Saint Cyprien (Dordogne), Sauveterre and Fumel (Lot-et-Garonne), by M. Ph. Glangeaud.

DIARY OF SOCIETIES.

MONDAY, FEBRUARY 4.

VICTORIA INSTITUTE, at 4.30.—Ancient Script in Australia: E. J. Statham.

TUESDAY, FEBRUARY 5.

ROYAL INSTITUTION, at 3.—Practical Mechanics: Prof. J. A. Ewing.

ZOOLOGICAL SOCIETY, at 8.30.—On the Mammals of the Balearic Islands: Oldfield Thomas.—On the Structure of the Horny Excrescence known as the "Bonnet" of the Southern Right Whale (*Balaena australis*): Dr. W. G. Ridewood.—A List of the Batrachians and Reptiles obtained by Dr. Donaldson Smith in Somaliland in 1899: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Present Condition and Prospects of the Panama Canal Works: J. T. Ford.

WEDNESDAY, FEBRUARY 6.

ROYAL INSTITUTION, at 3.—Government and People of China: Prof. R. N. Douglas.

GEOLOGICAL SOCIETY, at 8.—On the Origin of the Dunmail Raise (Lake District): D. Oldham.—On the Structure and Affinities of the Rhætic Plant *Naiadita*: Miss Igerna B. J. Sollas.

THURSDAY, FEBRUARY 7.

ROYAL SOCIETY, at 4.30.—*Probable papers*: The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers: Prof. Dewar, F.R.S.—On the Brightness of the Corona of January 22, 1898. Preliminary Note: Prof. H. H. Turner, F.R.S.—Preliminary Determination of the Wave Lengths of the Hydrogen Lines, derived from Photographs taken at Ovar at the Eclipse of the Sun, 1900, May 28: F. W. Dyson.—Investigations on the Abnormal Outgrowths or Intumescences on *Hibiscus vitifolius*, Linn.: a Study in Experimental Plant Pathology: Miss E. Dale.—On the Proteid Reaction of Adamkiewicz, with Contributions to the Chemistry of Glyoxylic Acid: F. G. Hopkins and S. W. Cole.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Action of Hydrogen Bromide on Carbohydrates: H. J. H. Fenton and Mildred Gostling.—Note on a Method of comparing the Affinity-Values of Acids: H. J. H. Fenton and H. O. Jones.—Organic Derivatives of Phosphoryl Chloride, and the Space Configuration of the Valencies of Phosphorus: R. M. Caven.—(1) Synthetical Work with Sodamide Derivatives: (2) Note on Two Molecular Compounds of Acetamide; (3) Diacetamide, a New Method of Preparation: Dr. A. W. Titherley.

RÖNTGEN SOCIETY, at 8.—Experiences of X-Ray Work during the Siege of Ladysmith; Lieut. F. Bruce.

FRIDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 9.—History and Progress of Aërial Locomotion: Prof. G. H. Bryan, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION, at 8.—Annual General Meeting.—Twelve Years of London Geology: The President, W. Whitaker, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mr. Wimperis' paper on Cycle Resistance will be submitted for discussion.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Power-Gas and Large Gas-Engines for Central Stations: H. A. Humphrey.

ANATOMICAL SOCIETY, at 4.30.—The Origin of the Vertebrate Ear and Eighth Pair of Cranial Nerves: W. H. Gaskell, F.R.S.—A Critical Review of Recent Literature on Fossil Anthropoids: W. L. H. Duckworth.

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